Rules and Regulations for the Classification of Naval Ships, January 2007

Notice No. 1

Effective Date of Latest Amendments:

See page 1

Issue date: November 2007

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RULES AND REGULATIONS FOR THE CLASSIFICATION OF NAVAL SHIPS, *January 2007*

Notice No. 1

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Naval Ships, January 2007.* The amendments are effective on the dates shown:

Volume	***Part***	***Chapter***	***Section***	***Effective date***
1	1	1	7	1 April 2006
1	3	2	3	1 January 2008
1	3	2	4	Corrigendum
1	3	3	4	1 January 2008
1	3	5	4, 6, 7, 9, 10	1 January 2008
1	4	1	2, 6	1 January 2008
1	5	3	5	1 January 2008
1	6	2	4	Corrigenda
1	6	3	3, 9, 14, 15	1 January 2008
1	6	6	4	1 January 2008
2	1	1	4, 6	1 January 2008
2	1	2	4	1 January 2007
2	1	2	3, 4	1 January 2008
2	2	1	1	1 January 2007
2	2	1	9, 11	1 January 2008
2	2	2	1	1 January 2007
2	2	3	4	1 January 2007
2	7	1	5	1 January 2008
2	7	3	1, 3, 4, 9	1 January 2008
2	7	5	1	1 January 2008
2	8	1	1, 18	1 January 2008
2	9	1	1, 2	1 January 2008
2	10	1	1	Corrigenda
2	10	1	1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 17	1 January 2008
3	1	3	2	1 January 2008
3	1	4	1, 2, 3, 5	1 January 2008
3	2	3	Whole Chapter	1 January 2008
3	3	4	8	1 January 2008

It will be noted that the amendments also include corrigenda, which are effective from the date of this Notice.

The *Rules and Regulations for the Classification of Naval Ships, January 2007* are to be read in conjunction with this Notice No. 1. The status of the Rules is now:

Rules for Naval Ships	Effective date:	January 2007
Notice No. 1	Effective dates:	1 April 2006, 1 January 2007, 1 January 2008 & Corrigenda

Volume 1, Part 1, Chapter 1

General Regulations

Effective date 1 April 2006

■ *Section 7*

(*Part only shown*)

7.1 The Committee has power to adopt, and publish as deemed necessary, Rules relating to classification and has (in relation thereto) provided the following:

(a) Except in the case of a special directive by the Committee, no new Regulation or alteration to any existing Regulation relating to character of classification or to class notations is to be applied to existing ships.

(b) Except in the case of a special directive by the Committee, or where changes necessitated by mandatory implementation of International Conventions, Codes or Unified Requirements adopted by the International Association of Classification Societies are concerned, no new Rule or alteration in any existing Rule is to be applied compulsorily after the date on which the contract between the ship builder and ship owner for construction of the ship has been signed, nor within six months of its adoption. The date of ‘contract for construction’ of a ship is the date on which the contract to build the ship is signed between the prospective ship owner and the ship builder. This date ~~is normally~~ and the construction number (i.e. hull numbers) of all the vessels included in the contract are to be declared to the Committee by the party applying for the assignment of class to a newbuilding.

The date of ‘contract for construction’ of a series of sister ships, including specified optional ships for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective ship owner and the ship builder. In this section a ‘series of sister ships’ is a series of ~~are~~ ships built to the same approved plans for classification purposes, under a single contract for construction. The optional ships will be considered part of the same series of sister ships if the option is exercised not later than 1 year after the contract to build the series was signed. If a contract for construction is later amended to include additional ships or additional options, the date of ‘contract for construction’ for such ships is the date on which the amendment to the contract is signed between the prospective ship owner and the ship builder. The amendment to the contract is to be considered as a ‘new contract’. Where it is desired to use existing approved ship or machinery plans for a new contract, written application is to be made to the Committee.

Volume 1, Part 3, Chapter 2

Ship Design

Effective date 1 January 2008

■ *Section 3*
Main hull structure

3.8 Deep tank structure

3.8.7 A centreline bulkhead is, generally, to be fitted in deep tanks which extend from side to side. The bulkhead may be intact or perforated as desired. If intact, the scantlings are to comply with the requirements of Part 6 for tank boundary bulkheads. If perforated, they are to comply with the requirements of Part 6 for wash plates. ~~The area of perforation is to be not less than five per cent nor more than 10 per cent of the total area of the bulkhead~~. Where brackets from horizontal girders on the boundary bulkheads terminate at the centreline bulkhead, adequate support and continuity are to be maintained.

CORRIGENDUM

■ *Section 4*
Bulkhead arrangements

4.1 General

4.1.5 Bulkheads forming the boundaries to citadels and zones as defined in Pt 4, Ch 1,7 other than watertight bulkheads, are usually required by the Naval Authority to be gastight. *See also* 4.8. Where specifically required by the Naval Authority, LR can ~~access~~ assess the gastight integrity of defined gastight boundaries, *see* Pt 6, Ch 6,6.8.

Volume 1, Part 3, Chapter 3

Ship Control Systems

Effective date 1 January 2008

■ *Section 4*

Rudder horns and appendages

4.5 Shaft brackets

~~*4.5.7* Where the shaft and the shaft bracket boss are of the same material, the length and thickness of the shaft bracket boss are to be not less than 4d_t and d_t/4, respectively, where d_t is the Rule diameter of the screwshaft, in mm.~~

4.5.7 The length of the shaft bracket boss, l_b, is to be sufficient to support the length of the required bearing. In general, l_b is not to be less than 4d_t, where d_t is the Rule diameter of the screwshaft, in mm, *see* Vol 2, Pt 3, Ch 2,4.4. Proposals for a reduction in the required shaft bracket boss length will be considered in conjunction with details of the bearing material, allowable bearing operating pressure and installation arrangements, *see* Vol 2, Pt 3, Ch 2,4.16.2. However in no case is l_b to be less than the greater of:

(a) 2d_t;
(b) that recommended by the bearing manufacturer;
(c) as required by 4.4.2.

(Part only shown)
4.5.8 ~~Where the shaft and the shaft bracket boss are of dissimilar materials, the length of the boss is to be not less than 4d_t, and the thickness, t_b, of the boss is to be not less than:~~Where the shaft and the shaft bracket boss are of the same material, the thickness of the shaft bracket boss is not to be less than d_t/4. Where the shaft and the shaft bracket boss are of dissimilar materials, the thickness of the boss, t_b, is to be not less than:

$$t_b = 0,75 d_t \left(\sqrt[3]{f_1 - 0,667} \right) \text{ mm}$$

Volume 1, Part 3, Chapter 5

Anchoring, Mooring, Towing, Berthing, Launching, Recovery and Docking

Effective date 1 January 2008

■ *Section 4*

Anchors

4.1 General

4.1.4 Ships are to be provided with the number of anchors as specified in Table 5.4.1 on board which must be ready for immediate use. Where this is impractical, *see* 9.3.4, special consideration may be given to only having one anchor ready for immediate use.

4.1.8 Where ships are required by the Naval Authority to be fitted with kedge anchors, they are to be in accordance with Table 5.6.1.

4.2 ~~Materials~~ Manufacture and testing of anchors

4.2.1 The requirements for the manufacture, testing and certification of anchors are contained in ~~Pt 2~~, Chapter 10 of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials).

4.4 High Holding Power (HHP) type anchors

4.4.1 Anchors of designs for which approval is sought as high holding power anchors are to be tested ~~at sea to show that they have holding powers of at least twice those approved of standard stockless anchors of the same mass.~~ in accordance with Chapter 10 of the Rules for Materials.

~~*4.4.2* If approval is sought for a range of sizes, then at least three sizes are to be tested, representative of the bottom, middle and top of the range. The smallest anchor in the range is to be tested. The largest anchor to be tested is to have a mass not less than half that of the largest anchor in the range. If the range is large such that the middle anchor to be tested is greater than twice the mass of the smallest anchor or less than half the mass of the largest anchor to be tested, then additional anchors may require to be tested.~~

~~*4.4.3* The tests are to be conducted on not less than three different types of bottom, which are normally to be soft mud or silt, sand or gravel, and hard clay or similarly compacted material.~~

~~*4.4.4* The tests are to be at full scale using a tug or other suitable vessel and the holding force measured by dynamometer incorporated within the anchor rode system. The dynamometer used is to produce a continuous readout in numerical and graphical form. A scope of 10 is recommended for the anchor cable, but in no case is a scope of less than six to be used. The same scope is to be used for the anchor for which approval is sought and the anchor that is being used for comparison purposes.~~

~~*4.4.5* High holding power anchors are to be of a design that will ensure that the anchors will take effective hold of the sea bed without undue delay and will remain stable, for holding forces up to those required by 4.6.1, irrespective of the angle or position at which they first settle on the sea bed when dropped from a normal type of hawse pipe. In case of doubt, a demonstration of these abilities may be required.~~

■ *Section 6*
Mooring ropes

6.1 Mooring ropes

6.1.1 Ships under 90 m require mooring lines as specified in Table 5.6.1. ~~Mooring lines may be of wire, natural fibre or synthetic fibre. The diameter, construction and specification of wire or natural fibre mooring lines are to comply with the requirements of Pt 2, Ch 10. Where it is proposed to use synthetic fibre ropes, the size and construction will be specially considered.~~

6.2 Materials

6.2.2 The design loads applied to deck fittings by 6.6 relate to conventional fibre ropes (i.e. polypropylene, polyester and nylon). If other materials are used i.e. HMPE, consideration should be given to the elongation properties and therefore the design load applied to deck fittings.

6.2.3 Wire rope mooring lines used in association with winches (on which the rope is stored on the winch drum) are to be of suitable construction.

Table 5.6.1 Equipment – Kedge anchors, wires and mooring lines

Equipment Number		Equipment Letter	Mass of stockless kedge anchor, in kg	Kedge anchor wire or chain (1) & (2)		Mooring lines (2)		
Exceeding	Not Exceeding			Minimum length, in metres	Minimum breaking strength, in kN	Number	Minimum length of each line, in metres	Minimum breaking strength, in kN
50	70	A	68	110	46	~~2~~ 3	~~100~~ 80	~~34,3~~ 34
70	90	B	90	110	58	~~2~~ 3	100	~~36,8~~ 37
90	110	C	113	124	75	~~2~~ 3	110	~~39,2~~ 39
110	130	D	135	124	90	~~2~~ 3	110	~~44,1~~ 44
130	150	E	158	138	90	~~2~~ 3	120	~~49,0~~ 49
150	175	F	180	138	122	~~2~~ 3	120	~~54,4~~ 54
175	205	G	214	151	106	~~2~~ 3	120	~~58,0~~ 59
205	240	H	248	151	140	~~2~~ 4	120	~~64,2~~ 64
240	280	I	292	165	166	~~3~~ 4	120	~~71,1~~ 69
280	320	J	338	179	195	~~3~~ 4	140	~~78,5~~ 74
320	360	K	383	179	225	~~3~~ 4	140	~~85,8~~ 78
360	400	L	428	193	257	~~3~~ 4	140	~~93,2~~ 88
400	450	M	484	193	292	~~3~~ 4	140	~~100,5~~ 98
450	500	N	540	206	328	~~3~~ 4	140	~~107,9~~ 108
500	550	O	597	206	328	4	160	~~112,8~~ 123
550	600	P	653	220	366	4	160	~~117,7~~ 132
600	660	Q	720	220	406	4	160	~~122,6~~ 147
660	720	R	788	220	448	4	160	~~127,5~~ 157
720	780	S	855	233	491	4	170	~~132,4~~ 172
780	840	T	923	233	540	4	170	~~137,3~~ 186
840	910	U	990	233	585	4	170	~~142,2~~ 201
910	980	V	1069	248	635	4	170	~~147,1~~ 216
980	1060	W	1148	248	685	4	180	~~156,9~~ 230
1060	1140	X	1238	248	685	4	180	~~166,7~~ 250
1140	1220	Y	1328	261	740	4	180	~~176,5~~ 270
1220	1300	Z	1418	261	795	4	180	~~186,3~~ 284
1300	1390	A †	1519	261	855	4	180	~~196,1~~ 309
1390	1480	B †	1620	275	905	4	180	~~205,9~~ 324
1480	1570	C †	1721	275	970	5	190	~~215,7~~ 324
1570	1670	D †	1834	275	1030	5	190	~~225,6~~ 333
						~~for ships over 90 m in length, see 6.1.3~~		
1670	1790	E†	1969	289	1095	5	190	353
1790	1930	F†	2104	289	1155	5	190	378
1930	2080	G†	2250	289	1225	5	190	402
2080	2230	H†	2419	302	1290	5	200	422
2230	2380	I†	2588	302	1395	5	200	451
2380	2530	J†	2759	302	1505	5	200	480
2530	2700	K†	2925	316	1580	6	200	480
2700	2870	L†	3113	316	1690	6	200	490
2870	3040	M†	3263	316	1805	6	200	500
3040	3210	N†	3488	330	1805	6	200	520
3210	3400	O†	3713	330	1925	6	200	554
3400	3600	P†	3938	330	2045	6	200	588
3600	3800	Q†	4163	344	2130	6	200	618
3800	4000	R†	4388	344	2255	6	200	647
4000	4200	S†	4613	344	2340	7	200	647

NOTES

1. The rope used for kedge anchor wire is to be constructed of not less than 72 wires, made up into six strands.
2. Steel wire and fibre ropes used for mooring lines and kedge anchors are to meet the requirements of the Rules for ~~the Manufacture, Testing and Certification of~~ Materials, ~~Pt 2,~~ Ch 10,6 and 7 respectively.
3. Wire ropes for mooring lines used in association with mooring winches (on which the rope is stored on the winch drum) are to be of suitable construction.
4. Irrespective of strength requirements, no fibre rope is to be less than 20 mm diameter.

6.4 Bollards, fairleads and bull rings

~~*6.4.2* Details showing the proposed scantlings of support arrangements for the bollards, fairleads and bull rings are to be subitted.~~

Existing 6.4.3 is to be renumbered 6.4.2

~~*6.4.4*~~ *6.4.3* Bollards, fairleads and bull rings are to be located on longitudinals, beams and/or girders, which are part of the deck construction so as to facilitate efficient distribution of the mooring load. Other equivalent arrangements (Panama chocks etc.) will be ~~specially~~ considered providing the strength is confirmed as adequate for the intended use.

~~*6.4.5* The design load to be applied is to be the greater of:~~

- ~~Twice the maximum breaking strength of the mooring line anticipated to be used throughout the service life of the ship~~
- ~~Twice the breaking strength of the mooring line according to Table 5.6.1.~~

~~*6.4.6*~~ *6.4.4* It is recommended that ~~The selection of~~ shipboard fittings are selected ~~is to be made by the shipyard~~ in accordance with an Industry standard (e.g. ISO3913 Shipbuilding Welded Steel Bollards) accepted by the Society. When the shipboard fitting is not selected from an accepted Industry standard, the design load used to assess its strength and its attachment to the ship is to be in accordance with ~~6.4.5~~ 6.6.3 and the design is to be submitted for approval.

~~*6.4.10*~~ *6.4.5* The SWL of each shipboard fitting is not to exceed ~~one half~~ 80 per cent of the design load as per 6.6.3. It is to be marked (by weld bead or equivalent) on the deck fittings used for mooring. The SWL with its intended use is to be noted in the ~~towing and~~ mooring arrangement plan or other information available on board for the guidance of the Master. These requirements for SWL apply for a single post basis (no more than one turn of one cable). The arrangement plan is to explicitly prohibit the use of mooring lines outside of their intended function.

~~*6.4.8* The acting point of the mooring force on shipboard fittings is to be taken at the attachment point of a mooring line or equivalent.~~

6.5 Mooring winches

6.5.1 Mooring winches where provided are to be suitable for the intended purpose. ~~Supports under the winches are to be to the Surveyor's satisfaction.~~

6.5.2 Mooring winches are to be fitted with drum brakes, the strength of which is sufficient to prevent unreeling of the mooring line when the rope tension is equal to 80 per cent of the breaking strength of the rope as fitted on the first layer on the winch drum~~, see also 6.4.1~~.

6.6 Support structure of deck fittings

6.6.1 Plans are to be of sufficient detail for plan approval purposes. Plans covering the following items are to be submitted for approval:

- Strong points, bollards and fairleads, *see* 6.4.4.
- Support structure and foundations of towing equipment.

6.6.2 A mooring arrangements plan is to be submitted for information and is to include the following in respect of each shipboard fitting:

- Location on the ship.
- Fitting type.
- Safe working load (SWL).
- Purpose of fitting (mooring/harbour towing/escort towing).
- Manner of applying towing or mooring line load, including limiting fleet angles.

A mooring arrangement plan is to be provided on board the ship for the guidance of the Master.

6.6.3 The design load to be applied to the supporting structure of mooring fittings is to be 1,25 times the minimum breaking strength of the mooring line according to Table 5.6.1 for the ship's corresponding equipment number. If a greater design load is specified by the Naval Authority this load is to be used.

6.6.4 The design load to be applied to the supporting structure of winches is to be 1,25 times the rated maximum holding power of the winch or the rated maximum pull power, whichever is greater.

6.6.5 The design load is to be applied according to the arrangement shown on the mooring arrangement plan. The point of action of the force on the fitting is to be taken as the point of attachment of the mooring line or towline or at a change in its direction. The total design load applied to a fitting need not be more than twice the design load, *see* Fig. 5.7.1.

~~*6.4.7*~~ *6.6.6* ~~Arrangement of the~~ The reinforced members (carling) beneath shipboard fittings are to be effectively arranged for ~~is to consider~~ any variation of direction (~~laterally~~ horizontally and vertically) of the mooring forces (which is to be not less than the design load ~~as per 6.4.5~~) acting through the arrangement of connection to the shipboard fittings. Other arrangements will be specially considered, provided that the strength is confirmed as adequate for the service.

~~*6.4.9*~~ *6.6.7* The stresses in shipboard fittings associated with mooring are not to exceed the specified minimum yield stress of the material in bending and 60 per cent of the specified minimum yield stress of the material in shear considering the design load ~~defined in 6.4.5~~.

■ *Section 7*
Towing arrangements

Table 5.7.1 Equipment - Minimum length and breaking strength of towlines

(*Part only shown*)

~~NOTES~~

~~1. Steel wire and fibre ropes used for towlines are to meet the requirements of the *Rules for Materials*, Vol 1, Pt 2, Ch 10,6 and 7 respectively.~~

~~2. Wire ropes for towlines used in association with mooring winches (on which rope is stored on the winch drum) are to be of suitable construction.~~

7.3 Materials

~~*7.3.1* The requirements for materials are contained in the *Rules for the Manufacture, Testing and Certification of Materials* (Vol 1, Part 2).~~

~~*7.3.2*~~ *7.3.1* Towing hawsers and towing pennants can be of steel wire rope, natural fibre or synthetic fibre. The diameter, construction and specification of steel wire or fibre towlines are to comply with ~~Pt 2,~~ Chapter 10~~,6 and 7 respectively~~ of the Rules for Materials. Where synthetic fibre ropes are used the size and construction will be specially considered.

~~*7.3.3*~~ *7.3.2* Where a length of chafing chain is included in the arrangement, it is to comply with ~~Pt 2,~~ Chapter 10 of the Rules for the Materials.

7.3.3 The design loads applied to deck fittings by this Section relate to conventional fibre ropes (i.e. polypropylene, polyester and nylon). Consideration should be given to the elongation properties of the actual line used.

7.3.4 Wire ropes used in association with winches (on which the rope is stored on the winch drum) are to be of suitable construction.

7.4 Information required

7.4.1 Plans are to be of sufficient detail for plan approval purposes. Plans covering the following items are to be submitted for approval:

- Strong points, bollards and fairleads, see 7.5.7.
- Support structure and foundations of towing equipment.

~~*7.4.2* The following supporting documents are to be submitted for information:~~

- ~~Towing arrangements, including lines of action, magnitudes and corresponding points of application of towline pulls on towing equipment.~~
- ~~Details of the breaking strength of the components of the towline system, together with maximum pull and brake holding power, or equivalent, of mooring winches or anchor windlasses included in the towing arrangement.~~
- ~~Manufacturer's certificates for all steel or fibre rope used in the arrangement.~~
- ~~Proof that bollards or fairleads used in the arrangement comply with 7.6.5.~~

7.4.2 The towing arrangement plan is to be submitted for information. It is to include the following in respect of each shipboard fitting:

- Location on the ship.
- Fitting type.
- Safe working load (SWL).
- Manner of applying towing line load, including limiting fleet angles.

The towing arrangement plan is to be provided onboard the ship for the guidance of the Master.

~~*7.4.3* The Safe Working Load (SWL) of all towing arrangement components is to be noted in the towing and mooring arrangement plan or equivalent information on board the vessel, *see* 7.6.11.~~

7.5 Towing arrangements

7.5.2 The fixed towing equipment is to comprise a securing arrangement which is a strong point and may be in the form of a stopper, bracket, deck clench~~, windlass~~ or towing slip. A fairlead, rollers or other appropriate towline guides as necessary are to be included in the arrangement.

7.5.3 Loose towing equipment is to comprise a towing hawser and a towing pennant. The towing pennant may comprise a length of chafing chain. In the absence of a length of chafing chain, suitable arrangements (e.g. a low friction sheath) are to be provided.

7.5.7 The selection of shipboard fittings is to be made by the shipyard in accordance with an acceptable National or International standard. If the shipboard fitting is not selected from an acceptable National or International standard then the design load used to assess its strength and its attachment to the ship is to be in accordance with the design load given in 7.6.3. The design is to be submitted for approval. Any weld, bolt or equivalent device connecting the shipboard fitting to the supporting structure is part of the shipboard fitting and is subject to the National or International standard applicable to that shipboard fitting.

7.5.8 Deck fittings and strong points are to be located on longitudinals, beams and/or girders, which are part of the deck construction so as to facilitate efficient distribution of the towing load. Other equivalent arrangements will be considered, providing the strength is confirmed as adequate for the intended use.

~~7.5.7~~ 7.5.9 To avoid chafing, the arrangement is to be designed so that no element of the loose towing equipment, when under tension is to contact with the ship's hull at any point other than those specified as a securing arrangement, fairlead or guide. The final point of contact of the towline with the ship is to be positioned as close as practicable to the centre line so as to ~~lower the~~ reduce the adverse ~~affect~~ effect on manoeuvrability.

Existing paragraphs 7.5.8 to 7.5.11 have been renumbered 7.5.10 to 7.5.13.

~~7.5.12~~ 7.5.14 The SWL of each shipboard fitting is to be clearly marked, by weld bead or equivalent, on each of the fittings used for towing, *see* ~~7.6.11~~ 7.6.10.

7.6 Strength requirements for towing arrangements

(Part only shown)

7.6.1 The ~~actual~~ minimum Breaking Load (hereinafter referred to as *BL*), ~~as specified in the National or International Standard to which the~~ of the towing hawser ~~carried on board the ship is assessed~~, in tonnes, is not to be less than that calculated below:

$BL = (0{,}03\Delta^{2/3} + (C_{mw} A_t))K$

where

Δ = displacement, in tonnes, to the deep ~~draft~~ draught waterline

7.6.2 The strength of other loose towing equipment e.g. links, shackles rings and chafing chain is to be determined on the basis of ~~an~~ a design ~~applied~~ load equal to ~~1,3~~ 1,25 times the *BL* of the towing hawser. If a greater design load is specified by the Naval Authority this load is to be used.

7.6.3 The strength of ~~strong points, bollards, fairleads and~~ shipboard fittings and their supporting structure is to be determined on the basis of ~~an~~ a ~~applied~~ design load equal to ~~twice~~ 1,25 times the *BL* of the towing hawser. If a greater design load is specified by the Naval Authority, this load is to be used. The design load is to be applied through the towline according to the arrangement shown on the towing arrangement plan. The point of action of the force on the fitting is to be taken as the point of attachment of the mooring line or towline or at a change in its direction. The total design load applied to a fitting need not be more than twice the design load, *see* Fig. 5.7.1.

7.6.4 The stress in all loose and fixed towing equipment constructed of steel, and its supporting structure, is not to exceed the specified minimum yield stress of the material in bending and 60 per cent of the specified minimum yield stress of the material in shear. Special consideration will be given if the vessel and/or towing equipment is not constructed of steel.

7.6.5 ~~Arrangement of the~~ The reinforced members (carling) beneath shipboard fittings are to be effectively arranged for ~~is to consider~~ any variation of direction (~~laterally~~ horizontally and vertically) of the ~~mooring~~ towing forces (which is to be not less than the design load ~~as per 7.6.3~~) acting through the arrangement of connection to the shipboard fittings. Other arrangements will be specially considered provided that the strength is confirmed as adequate for the service.

7.6.6 For the assessment of fairleads and their supporting structure, due consideration must be given to lateral loads.The strength of the fairlead ~~must~~ is to be sufficient for all angles of towing load up to 90° horizontally from the ship's centreline and 30° vertically from the horizontal plane.

7.6.9 Strong points ~~and fairleads~~ are to be fitted in way of a transverse or longitudinal deck girder or beam to facilitate efficient distribution of the towing load.

~~*7.6.10* Mooring winches included in the towing arrangement are to have an appropriate brake holding power to that of the *BL* of the towing hawser. The holding capability should be calculated for the outermost towline layer on the winch drum at which towing will be performed.~~

~~7.6.11~~ 7.6.10 The SWL of each towing arrangement component is to be no greater than ~~one half~~ 80 per cent of the design load applied.

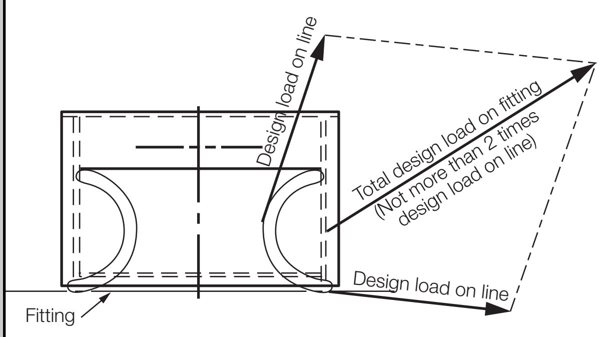


Fig. 5.7.1 **Design load applied to fittings**

■ *Section 9*
Structural details

9.3 Hawse pipes and anchor recesses

~~*9.3.4* The silting of the haws pipe for conventional bower anchors depends upon the shape of the forebody and the bow contour of the vessel and sufficient clearance is to be given between the anchor flukes in the most critical position and other underwater bow contours including sonar domes. Alternatively, where bow sonar domes are fitted the main bower anchor is to be positioned on the centreline with recesses anchor is to be positioned on the centreline with recessed anchor stowage and the sheet/stream anchor, conventionally positioned, is only to be used in an emergency.~~

9.3.4 The lines of the bow are to be taken into consideration when siting the anchor recesses for conventional bower anchors. Sufficient clearance of the flukes from the hull is to be maintained over the whole of the anchor run, above and below the water, considering the flukes in the most critical position. If a bow sonar dome is fitted, consideration is to be given to the positioning of the anchor recesses to reduce the possibility of the anchor chain rubbing on the dome when the anchor is in the deployed position.

■ *Section 10*
Launch and recovery, berthing and docking arrangements

10.2 Docking loads

10.2.1 Docking a ship on blocks potentially imposes high vertical loads on the keel. ~~The~~ For ships where the Rule length, LR, exceeds 50m, the strength of the keel and double bottom structure is to be assessed. ~~using~~ Methods, other than the simplified method or direct calculation method described here, for demonstrating that the strength of the structure is ensured against the loads imposed by docking may be considered and are to be agreed with LR.

10.2.2 It is recommended that for ships of fine hull form or where W_{oh}, as defined in 10.2.6, at any block becomes negative, the docking load distribution is derived by direct calculation using a full ship finite element model constructed generally in accordance with the ShipRight SDA procedure for Passenger Ships. The model is to be supported on grounded spring elements representing the dock block arrangement as given in the docking plan. Calculations should be carried out for a representative number of docking conditions. The spring element stiffness in the model should be representative of the block and capping stiffness. An assessment of the result should be carried out to ascertain the sensitivity of the structural response to the spring constant used. Under the application of the loads, the acceptance criteria given in Table 5.10.1 are not to be exceeded. The appropriate buckling criteria of Pt 6, Ch 2,4 are to be applied using the minimum buckling factor given in Table 5.10.1.

10.2.3 For full bodied ships or where a more detailed assessment is impractical, a simplified method may be used where a line load at the keel equal to the following equation is distributed equally over blocks in that section. For normal block spacing, the load on the keel can be taken as a distributed line load.

~~$F_{DL} = \frac{g\,W_c}{L_c}$~~

$$F_{DL} = \frac{g\,W_c f_{bhd}}{L_c} \quad \text{kN/m}$$

where
W_c = weight of the length between main transverse bulkheads in tonnes
f_{bhd} = correction factor to be applied within 1 frame of transverse bulkheads
= 2, within one frame of transverse bulkheads
= 1, elsewhere
g = acceleration due to gravity, 9,81m/s^2
L_c = distance between main transverse bulkheads, in metres.

existing paragraph 10.2.2 is to be renumbered 10.2.4

~~*10.2.3*~~ *10.2.5* When an overlap of the forward and aft overhang correction curves occurs, both curves are to be included in the total line load over a section. This will increase the possibility that blocks amidships will become unloaded, *see* 10.2.2.

existing paragraphs 10.2.4 and 10.2.5 are to be renumbered 10.2.6 and 10.2.7

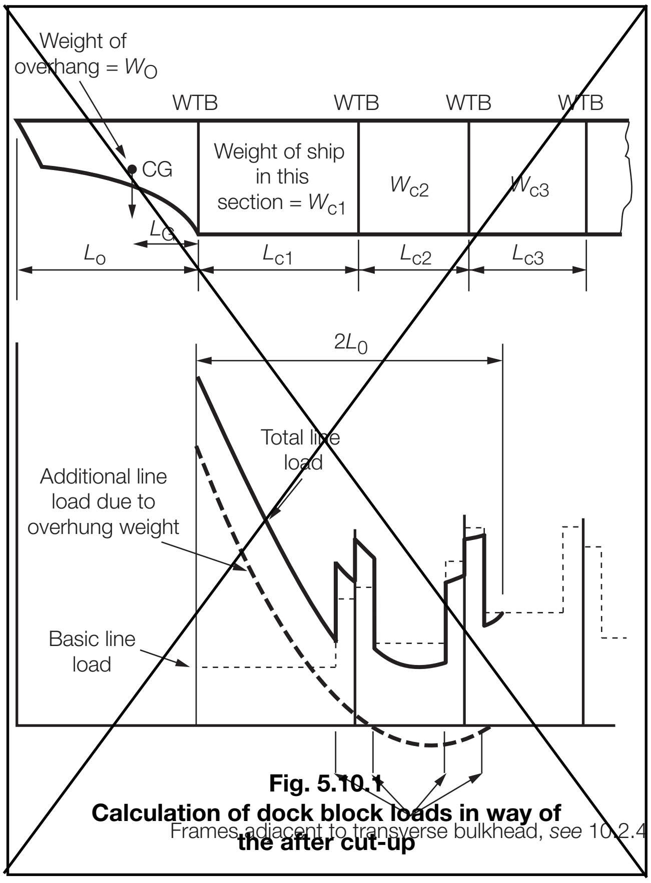
Table 5.10.1 Acceptance criteria

Structural Item	Allowable stresses, *see* Note		Minimum Buckling factor
	σ_e	τ	λ
Double bottom girders	$0{,}75\sigma_L$	$0{,}35\sigma_o$	1,2
Double bottom floors	$0{,}75\sigma_L$	$0{,}35\sigma_o$	1,1

NOTE

In areas where the openings have not been modelled, the resulting shear stress and Von Mises stress is to be corrected according to the ratio of the actual to the modelled shear area. If the resulting stress levels exceed 90% of the specified allowable values, further study by means of fine mesh follow up models may be required. Von Mises stresses are to be recalculated on the basis of the corrected shear stresses.

σ_o = specified minimum yield stress of material. σ_o for steels having a yield stress above 355 N/mm^2 will be specially considered
$\sigma_L = \frac{235}{k_L}$ N/mm^2
λ = factor against elastic buckling
σ_e = von Mises equivalent stress = $\sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_y\sigma_x + 3\tau_{xy}^2}$


Weight of overhang = W_O
WTB
WTB
WTB
WTB
CG
Weight of ship in this section = W_{c1}
W_{c2}
W_{c3}
L_G
L_o
L_{c1}
L_{c2}
L_{c3}
$2L_0$
Total line load
Additional line load due to overhung weight
Basic line load
Frames adjacent to transverse bulkhead, see 10.2.4

~~**Fig. 5.10.1**~~
~~**Calculation of dock block loads in way of the after cut-up**~~

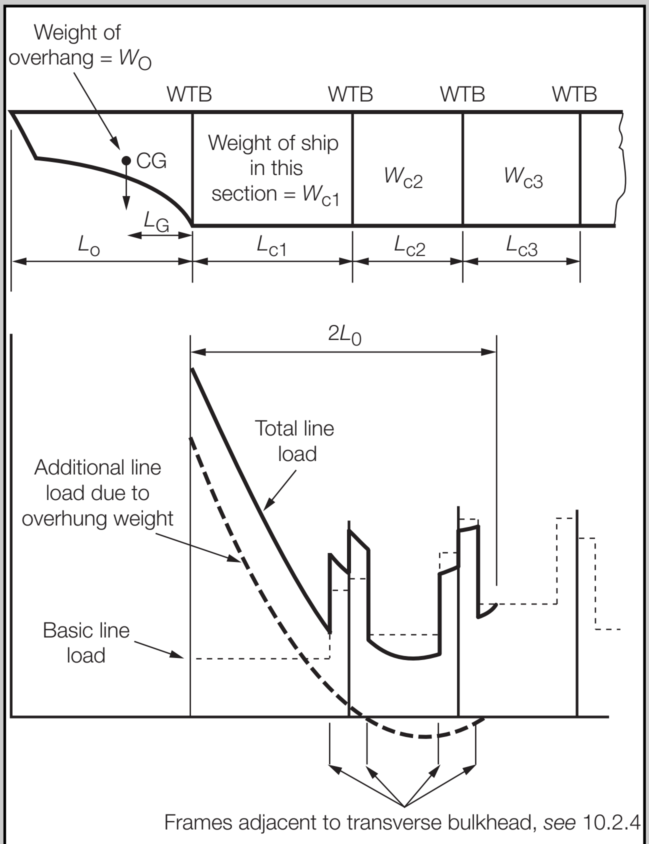

Weight of overhang = W_O
WTB
WTB
WTB
WTB
CG
Weight of ship in this section = W_{c1}
W_{c2}
W_{c3}
L_G
L_o
L_{c1}
L_{c2}
L_{c3}
$2L_0$
Total line load
Additional line load due to overhung weight
Basic line load
Frames adjacent to transverse bulkhead, *see* 10.2.4

Fig. 5.10.1
Calculation of dock block loads in way of the after cut-up

Volume 1, Part 4, Chapter 1

Military Design

Effective date 1 January 2008

■ *Section 2* **Survivability**

2.2 Vulnerability

2.2.2 This Chapter deals separately with the effects of a threat on the structure but when considering the total vulnerability of the ship it will be necessary to combine all the effects of a weapon detonation to determine the total damage to the ship as a system. This is normally done ~~during~~ very early in the design stage at a low level of complexity, *see* 2.1.4. Several computer codes are available to determine the consequence of weapon threats on the ship system.

■ *Section 6*
~~Design guidance for magazines~~
Magazine design and construction requirements

6.1 General

6.1.1 ~~The requirements for the design, construction and maintenance of magazines are to be in accordance with the regulatory requirements specified by the Naval Authority. Recognised regulatory requirements should generally be in line with the requirements of this Section.~~
The design, construction and maintenance of magazines are to be in accordance with Naval Authority Regulations. All Regulations, recommendations and requirements are to be confirmed to have been applied. *See* Vol 1, Pt 1, Ch 2,1.1.12.

6.1.2 Where Naval Authority Regulations are not specified, the following requirements apply: Risk assessment may be used to justify alternative arrangements. This is to be approved by the Naval Authority or organisation acting on the Naval Authorities behalf. All recommendations and requirements are to be demonstrated to have been applied.

~~*6.1.2*.~~ *6.1.3* A statement of magazine requirements ~~should~~ is to be defined and ~~should~~ is to include:

(a) Armaments requirement; listing the expected munitions and materiel to be carried in magazines. Identifying the items which can or ~~should~~ are to be co-located and those which must be stored separately or separated. Any special requirements for the storage of particular items are also to be listed including:
    (i) environmental conditions; and
    (ii) ~~shock protection requirements;~~
    ~~(iii)~~ conductive deck coating requirements~~;~~ .
    ~~(iv)~~ ~~rocket reaction loads.~~
(b) Construction materials requirement; describing the permissible materials or required alternatives for magazine structures and munition stowages.
~~(c)~~ ~~Incident mitigation requirement; describing the measures to be adopted to mitigate the effects of the firing of stored munitions or rockets.~~
~~(d)~~ (c) Magazine Labelling requirement; describing the required labels and their locations.
~~(e)~~ (d) Fluid Systems requirement; describing the operating fluids and operating pressures of all fluid systems within the magazine boundaries.
(e) Munition handling requirement: describing the equipment and space requirements to enable the munitions to be safely handled, maintained and stowed.

~~*6.1.3* The postulated credible accident requirements are to be based on the results of a hazard evaluation with regard to the magazine, munitions stowage, handling and transportation.~~

~~*6.1.4* Hazards that should normally be considered include:~~
~~(a)~~ ~~Hostile action, a detonation of a threat munition leading to fragmentation and, or shock or blast loading on the munition. A vulnerability analysis as described in Ch 1,2 may be used to identify the risk.~~
~~(b)~~ ~~Fire, from hostile action or peace time incident.~~
~~(c)~~ ~~Terrorist attack or sabotage.~~
~~(d)~~ ~~Handling incidents, from dropping the munition or impact by handling equipment.~~
~~(e)~~ ~~Aircraft incident on the flight deck.~~
~~(f)~~ ~~Ship collision or grounding.~~
~~(g)~~ ~~Electro magnetic interference (EMI) and electrostatic effects (ESD) causing accidental initiation.~~
~~(h)~~ ~~Nuclear effects.~~
~~(i)~~ ~~Air conditioning failure.~~

~~*6.1.5* The hazard assessment should be undertaken from two points of view. Firstly, a threat external to the munition causing an incident within the magazine. The aim of protection or mitigation being to prevent the blast, heat radiation, bullet or fragment reaching the munition. Secondly the threat of the initiation or detonation of the munition. The aim of protection being to prevent communication between magazines or a sympathetic reaction and to reduce the damage volume, hence minimising the effect on integrity and survivability of the ship. In addition to 6.1.4, the following specific threats to the munition, should be considered:~~
~~(a)~~ ~~12,7 mm bullet attack.~~
~~(b)~~ ~~Sympathetic reaction.~~
~~(c)~~ ~~Liquid fuel fire.~~
~~(d)~~ ~~Fragment attack.~~
~~(e)~~ ~~Slow heating.~~
~~(f)~~ ~~Propulsion motor firing.~~

~~*6.1.6* The risk to magazines and consequently their location within the ship's hull is to be determined by a vulnerability assessment, see Ch 1,2~~

~~*6.1.7* Magazines, designated danger areas and compartments adjacent to magazines are to be fitted out electrically with the requirements specified by the Naval Authority in accordance with National standards.~~

~~*6.1.8*~~ *6.1.4* Munition securing and handling equipment is to be in accordance with requirements of the Armaments Requirement or, with special consideration, LR's LAME Code. Explosive stores are to be classified and stowed in accordance with the armament requirement, *see* ~~6.1.2~~. 6.1.3.

~~*6.1.9* In general, both a primary and secondary ammunitioning route are to be provided for munitions from their embarkation point to their dedicated permanent stowage. In addition, primary and secondary routes should be provided from the permanent stowage to ready use lockers, magazines or the point of use. Handling equipment along these routes is to be in accordance with the requirements of 6.1.8.~~

~~*6.1.10*~~ *6.1.5* Ready use magazines ~~shall~~ are not to be used for the permanent stowage of munitions. They are to comply with the requirements of this Section for the appropriate magazine type.

6.2 Definitions

6.2.1 Munitions are a complete device (e.g. missile, shell, mine, demolitions store, etc., charged with explosives, propellant, pyrotechnics, or initiating composition ~~or nuclear, biological or chemical material~~), for use in conjunction with offensive, defensive, training, or non-operational purposes, including those parts of the weapon systems containing explosives.

6.2.2 Explosives are all weapons, missiles or stores containing substances especially designed to produce an explosive, propulsive, incendiary or pyrotechnic effect for use in conjunction with offensive, defensive, training, or non-operational purposes.

~~*6.2.2*~~ *6.2.3* Integral magazines are those which are bounded by the elements of the main hull structure. They are specifically designed and constructed for the safe permanent stowage of the main outfit of designated munitions defined in the armaments requirement, *see* ~~6.1.2.~~ 6.1.3.

Existing paragraph 6.2.3 is to be renumbered 6.2.4

~~*6.2.4*~~ *6.2.5* Small magazines are compartments opening off the upper deck which are of shape and size which does not permit walk-in and where the contents are handled from outside. Small magazines are to be specifically designed and constructed for the safe permanent or ready use stowage of munitions defined in the armaments requirement, *see* ~~6.1.2.~~ 6.1.3.

Existing paragraphs 6.2.5 to 6.2.8 are to be renumbered 6.2.6 to 6.2.9

~~*6.2.9* RATTAM is Response to ATTack on AMmunition and is protection provided to ship magazines to counter credible peacetime attacks.~~

~~*6.2.12* NEQ is the net explosive quantity and equal to the mass of the explosive content.~~

~~*6.2.13* Burning is defined as a Type V reaction which is the least violent type of event. The energetic material ignites and burns non propulsively. The case may split open non violently, or weaken significantly to allow mild release of combustion gases. Case closure may be dislodged by the internal pressure.~~

~~*6.2.14* Flame screens are a single screen of corrosion resistant wire of 144 meshes per cm2 using wire of 0,3 mm diameter. Alternatively they can consist of two corrosion resistant wires of 64 meshes per cm2 using wire of 0,4 mm diameter, spaced between 12 mm to 38 mm apart.~~

6.3 Arrangement of magazines

~~*6.3.1* Magazines are to be located to afford the maximum physical protection from damage emanating from all credible sources. In **NS1** and **NS2** ships, magazines are to be separated laterally and vertically by the greatest possible extent.~~

~~*6.3.2* If possible magazines are to be sited below the waterline with smaller ready use magazines located near to the point of use.~~

~~*6.3.3.*~~ *6.3.1* Integral magazines and small magazines containing munitions ~~above 57 mm diameter~~ or propellant are not to be sited adjacent to high fire risk and other compartments of high fire risk listed below:

(a) ~~Main~~ Machinery spaces ~~including diesel generator compartments, gas turbine compartments~~ of category A.
(b) Galleys.
(c) Switch boards or electrical control rooms.
(d) Tanks containing liquids with a flash point lower than 60°C or with a temperature above 32°C.
(e) Compartments containing liquid oxygen.
(f) Fuel, petrol, oil or lubricant pump spaces.
(g) Accommodation spaces.
(h) Control Spaces.

~~*6.3.4*~~ *6.3.2* Access is not permitted from any of the spaces defined in ~~6.3.3~~ 6.3.1, to the magazine.

~~*6.3.5*~~ *6.3.3* For ships where the above arrangement is completely impracticable the magazine is to be separated from the high risk space by a minimum 600 mm wide cofferdam and constructed of steel or an A-30 fire division. Cofferdams are to comply with the requirements of Pt 3, Ch 2,4.10, are to be ventilated and are not to be designed or used for stowage purposes.

Existing paragraph 6.3.6 is to be renumbered 6.3.4.

~~*6.3.7* Integral magazines and small magazines containing munitions of diameter less than 57 mm may be situated adjacent to the compartments listed in 6.3.3 provided they are separated by an A-30 fire division.~~

Existing paragraph 6.3.8 is to be renumbered 6.3.5

~~*6.3.9*~~ *6.3.6* ~~Generally, m~~Magazine lockers are to be sited in a safe location on a weather deck, ~~be~~ surrounded by an air gap of at least 300 mm on all sides and where applicable protected from direct sunlight by fitting solar cladding over top and sides with an air gap of at least 25 mm.

~~*6.3.10* Magazine lockers are not to be situated in any of the compartments listed in 6.3.4 and 6.3.8.~~

~~*6.3.11* Magazine lockers or boxes designated to contain RATTAM susceptible munitions must have suitable RATTAM protection, see Ch 2,4, or be sited such that they can not come under direct attack from small arms.~~

~~*6.3.12*~~ *6.3.7* Within magazines, arrangements are to be ~~made~~ such to ensure that all munitions, including those in transit packaging, are safely stowed and suitably restrained in their stowage~~. Munitions~~ for predicted motions and environmental conditions as identified in the armaments requirement ~~as susceptible to underwater shock are to be certified to meet the specified shock protection requirements.~~ Separate stowage is to be provided for each type of explosive except where specified by the armaments requirement, *see* ~~6.1.2~~ 6.1.3.

~~*6.3.13*~~ *6.3.8* ~~Certain munitions will also require m~~Magazines are to provide suitable electro-magnetic screening and earthing arrangements for munitions as identified in ~~accordance with~~ the armaments requirement, *see* ~~6.1.2~~. 6.1.3.

~~*6.3.14*~~ *6.3.9* ~~Generally m~~Magazine boxes are to be sited on a weather deck with an air gap of at least 300 mm between the box and the deck or surrounding deck houses. They are to be located in a position suitable for jettisoning of the contents and capable of remote release.

~~*6.3.15* Detonator lockers may be sited as agreed with the Naval Authority in nominated dry secure storerooms provided the total NEQ of the detonators does not exceed 1 kg per storeroom. Where the total NEQ of the detonators to be embarked exceeds 1 kg, stowage is to be provided either by siting detonator lockers in a dedicated detonator magazine, sited below the waterline, or in a number of dry secure storerooms.~~

6.3.10 Detonators are to be stowed separately from other explosives in dedicated lockers or storerooms; such spaces are to be treated as designated danger areas. Co-location may be allowed as identified in the armaments requirement, *see* 6.1.3 (a).

~~*6.3.16* Detonators lockers are not to be sited in compartments subject to; temperatures above 32°C, excessive vibration or which contain flammable liquids, solvents, mixed paints, acids or any other material liable to spontaneous combustion.~~

~~*6.3.17* Detonator lockers are not to be sited less than 100 mm from the compartment boundary, measured from the bulkhead plating and are not to be secured to the ship's side. The free air distance between Detonator lockers is not to be less than 300 mm. Where 300 mm cannot be achieved, they may be permitted with 100 mm air gap, provided that an 8 mm steel plate is fitted between each locker.~~

~~*6.3.18* Primary and secondary ammunitioning routes are to be as direct as possible, commensurate with safety. They are to be sheltered as far as practicable, from the physical and electromagnetic environment. The routes are to enable the munitions to be moved rapidly from the dump area to the permanent stowage, and, where required, to its ready use stowage or point of use, with the minimum amount of man power. The secondary route is not to be common with the primary route as far as is practicable.~~

6.4 Structure

6.4.1 Integral magazines are to be of permanent watertight or gastight construction (*see* Pt 3, Ch 2,1.3 and 7.7) and formed by permanent A-15 class divisions. A-0 class divisions may be allowed if spaces adjacent to the magazine do not contain flammable products.

6.4.2 Independent magazines are to be of weathertight metal construction, see Pt 3, Ch 2,1.3. The interior is to be insulated with a non-combustible insulation providing an A-15 standard.

~~*6.4.1*~~ *6.4.3* Magazine lockers and magazine boxes are to be constructed of steel ~~greater than 3 mm thickness~~. Other material may be accepted as identified in the construction materials requirement, *see* ~~6.1.2~~ 6.1.3.

~~*6.4.2* Integral magazines, small magazines or portable magazines are to be constructed of steel greater than 8 mm. Other material may be accepted as identified in the construction materials requirement, see 6.1.2.~~

~~*6.4.3* Where munitions are stowed in silos or canisters, precautions are to be taken to prevent the most severe response of explosive store to bullet attack causing a sympathetic reaction in adjacent stores greater than burning.~~

6.4.4 The scantlings of integral magazine boundaries are to be determined from Pt 6, Ch 3, Table 3.3.15 for NS1 ships and the general plating and stiffening equations in Pt 5, Ch 3,5.8 for other ships. The design pressure, P_{mag}, is to be derived as shown in Pt 5, Ch 3,5.11.

~~*6.4.4* The scantlings of magazine boundaries below the vertical limit of watertight integrity are to be determined from the general plating and stiffening equations in Pt 5, Ch 3,5.8 for deep tank or watertight bulkheads or the equivalent quasi-static pressure caused by the postulated credible accident whichever is greater. Scantlings of magazines above the vertical limit of watertight integrity are to be determined using the equivalent quasi-static pressure caused by the postulated credible accident.~~

~~*6.4.5* The scantlings of magazines with a free flood arrangements are to be designed using the general plating and stiffening equations of Pt 6, Ch 2,2 as appropriate with the pressure;~~
~~P = 11,2h kN/m2~~
~~where~~
~~h = height from the top of the outflow to the part of structure being considered, in metres.~~

~~*6.4.6* Arrangements are to be made to ensure that the magazine is not pressurised by the free flood or sprinkling arrangements and adequate automatic air escapes are to be arranged that vent to atmosphere. The automatic air escapes are to be designed to operate at 1,38 kN/m^2 or the elastic design capability of the magazine structure whichever is less.~~

~~*6.4.7* Pressure relief or blast vent plates are to be arranged to ensure that for the postulated credible accident, the pressure within the compartment does not rise above 80 per cent of that which would cause elastic failure of the bulkheads or decks. An equivalent quasi static pressure may be used to determine the elastic failure pressure of the bulkhead, calculations are to account for the response time of the venting system. In the absence of a specific requirement, the venting arrangements for magazines containing rocket motors, should be capable of venting the gases produced by the ignition of a single round or munition.~~

~~*6.4.8* Vent plates are to be capable of withstanding the force imposed by sea, weather or personnel where appropriate, see also Pt 3, Ch 4.~~

~~*6.4.9* Venting is to be direct to atmosphere or via a dedicated vent trunk. The cross sectional area of the trunk is not to be less than that required for the vent plate. The number of obstructions and bends within the vent trunk is to be kept to a minimum. Where they exist, their effect on the flows in the vent trunk is to be assessed. Vent trunks are to be as short as possible. When a large venting area is required more than one plate is to be fitted.~~

~~*6.4.10* Where the use of aluminium and/or GRP is defined in the construction materials requirement, in the boundaries of magazines, suitable fire protection is to be arranged on both sides of the boundary. The protection is to be such that the temperature response of the structure due to postulated credible accidents, from inside the magazine and out, does not exceed that which will cause significant reduction in the strength properties of the material.~~

6.4.5 If venting from the magazine space is via a vent trunk, the required scantlings for the vent trunk structure are to be calculated as for magazine boundary requirements.

6.4.6 Vent plate structure and fittings are to be designed to meet the appropriate deck or bulkhead pressure requirements according to location.

6.5 Environmental conditions and ventilation

~~*6.5.2* Compartments containing magazine lockers are to comply with the requirements of 6.5.1.~~

~~*6.5.3*~~ *6.5.2* The air conditioning may be recirculatory if confined to the ventilation of magazines only. If the magazine is to be ventilated with other compartments then the magazine is to vent to atmosphere. ~~In general h~~High fire risk and high value compartments should not share ventilation with magazines.

Existing paragraphs 6.5.4 & 6.5.5 are to be renumbered 6.5.3 & 6.5.4

~~*6.5.6* Temporary arrangements are to be provided to ensure that in the case of a system failure the temperature does not exceed 40°C in 12 hours.~~

~~*6.5.7* All magazine ventilation valves are to be capable of being operated both locally and remotely. The operating positions are to be sited as follows:~~

- ~~(a) Where the magazine is sited within the citadel, both the local and remote operating positions are to be sited inside the citadel.~~
- ~~(b) Where the magazine is outside the citadel, operating positions may be either inside or outside the citadel.~~
- ~~(c) Local and remote operating positions are to be sited in a readily accessible place with unrestricted access.~~
- ~~(d) Remote operating positions are to be sited in a place which allows operation without risk to personnel from the hazard in the magazine or at the local operating position. The remote position is to be separated from the local position by at least one watertight subdivision and must not be sited in an adjacent compartment.~~

~~*6.5.8*~~ *6.5.5* Ventilation trunking is to be of an equivalent fire integrity standard ~~airtight to the same pressure~~ as the magazine.

~~*6.5.9*~~ *6.5.6* Air conditioning and ventilation systems are to be designed to maintain watertight integrity~~,~~ and flash ~~and flame tightness, anti sabotage and NBCD integrity.~~

~~*6.5.10* In vessels which are designed to meet low magnetic signatures, trunking may be of a composite material as required by the construction materials requirement, *see* 6.1.2.~~

~~*6.5.11* Firesafe valves are to be fitted in both supply and exhaust trunking, external to the magazine boundary and near the bulkhead.~~

6.6 Detail arrangements

~~*6.6.1* All stowages, racks and associated fittings are to be constructed of steel unless otherwise specified in the construction materials requirement, *see* 6.1.2.~~

~~*6.6.2* A minimum free air space of 60 mm is to be maintained between stowages and bulkheads and stowages and the deck.~~

~~*6.6.3* Rockets are to be arranged such that their efflux does not impinge on any munitions within the magazine. Additional protection is to be provided to prevent efflux from burning through the magazine boundary. The rocket is to be adequately secured to satisfy the armaments requirement, *see* 6.1.2, in the event of motor firing.~~

~~*6.6.4* Following a hazard assessment, *see* 6.1.4, 6.1.5 and 6.1.6, internal protection may be necessary to reduce the effects of sympathetic reactions in magazines. If a munition is assessed as vulnerable, mitigation shall be adopted. Any of the following methods may be used singularly or in combination:~~

~~(a) Fracticide bars.~~
~~(b) Metal shielding.~~
~~(c) Water barriers.~~
~~(d) Plastic or ceramic barriers.~~
~~(e) Armour.~~

~~*6.6.5* Mitigation as required by 6.6.4, shall be afforded to 'sensitive' munitions to prevent accidental initiation and sympathetic reaction of munitions temporarily sited in weapon parks.~~

~~*6.6.6*~~ *6.6.1* Clear labelling of all magazine openings and equipment is to be maintained in accordance with the magazine labelling requirement, *see* ~~6.1.2~~. 6.1.3. The following requirements are to be applied as a minimum:

(a) Integral, small and independent magazines:
  (i) the space is a magazine.
  (ii) open lights and flame are to be kept away.
  (iii) the magazine door is to be kept shut.
  (iv) sources of ignition such as matches; lighters and pocket torches are to be removed prior to entry.
  (v) not to lift with contents (in the case of independent magazines).
  (vi) magazine otherside markings in adjacent compartments.
(b) Magazine lockers and boxes:
  (i) the container is a magazine locker or box.
  (ii) open lights and flame are to be kept away.
  (iii) the box is to be kept shut.
  (iv) not to lift with contents.

~~*6.6.7* The fitting of electrical equipment and cabling to the boundaries of magazines is to be avoided as far as practicable. Where this is unavoidable for equipment, items may be fitted to the boundary provided that there is a stand off of at least 60 mm to assist boundary cooling and minimise heat transference in case of fire.~~

~~*6.6.8* To facilitate handling of munitions and detonators, sloping ladders are to be fitted to compartments containing magazines and on ammunitioning routes. Where practicable, consideration should be given to the provision of chutes.~~

6.6.2 Magazines are to be insulated with non-combustible material as necessary to prevent the condensation of moisture.

6.7 Openings

~~*6.7.1* Doors, hatches, hoists or other openings in ship's structure are not to be placed in way of efflux. Where this is not practicable, they are to be flameproof when closed.~~

~~*6.7.2*~~ *6.7.1* Openings in the magazine and lockers such as doors, hatches and escape scuttles are to be of equivalent strength ~~to~~ and fire integrity as the surrounding structure.

~~*6.7.3* The openings of magazines containing munitions with propellant and magazine openings to areas where there is a risk from flash such as the hanger, weather deck or an ammunitioning route are to be either watertight, gastight or flashtight in accordance with Fig. 1.6.1. Suitable earthing of flash tight openings is to be arranged.~~

~~*6.7.4*~~ *6.7.2* Accesses to magazines are to be fitted with suitable security arrangements to prevent unauthorised access. ~~In general, o~~Openings are to be capable of being secured from the inside and fitted with external locks. Emergency escapes are to be opened from the inside only.

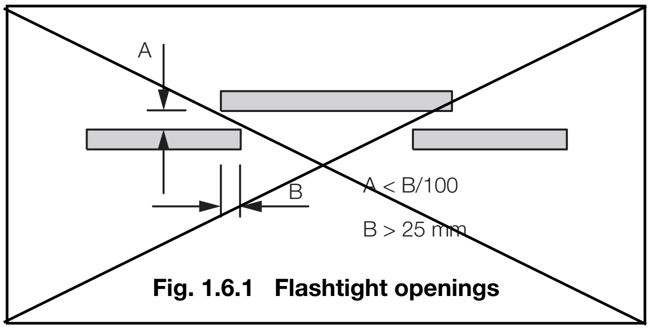


Fig. 1.6.1 Flashtight openings

Existing paragraph 6.7.5 is to be renumbered 6.7.3

6.8 Piping, cabling and electrical systems

6.8.1 ~~All equipment in magazines is to be intrinsically safe, see Vol 2, Pt 10, Ch 1,13.3. The installation of electrical equipment and cables in magazines is to be minimised as far as possible subject to operational requirements. Where it is necessary to install electrical equipment or cables they are to comply with the requirements of an appropriate standard defined by the Naval Authority. Equipment and cables are to be constructed from non flammable materials.~~

In order to eliminate potential sources of ignition, hazardous areas for magazines are to be identified and electrical equipment within the magazine is to be selected and installed in accordance with the requirements of Vol 2, Pt 10, Ch 1,13.

6.8.2 Lighting is to be operated from outside the space. Indication is to be provided at the switch location when circuits are energised.

6.8.3 All apparatus fitted in magazines is to be capable of being isolated on all poles from any source of electrical energy. The preferred method of isolation is by means of a multipole switch. Services that operate on low power at low voltage and are required to operate continuously do not require local isolation. Fire and flood detection and internal communications systems are included amongst such services.

~~*6.8.4* Switches and marker plates stating the method of isolation are to be sited outside the magazine in a prominent position on the access route to the main door.~~

~~*6.8.5*~~ *6.8.4* ~~Generally, o~~Only services which are required for equipment in the magazine are to penetrate boundaries of the magazine.

~~*6.8.6* Services that cross the boundary of the magazine which are vulnerable to sabotage are to have anti sabotage arrangements to prevent ingress of foreign bodies or fluids. In general, all vent trunks, exhaust outlets, air inlets and automatic air escapes are to be fitted with grilles and where appropriate, goose necks.~~

~~*6.8.7* Cabling other than for magazine equipment should not pass through the magazine. Degaussing, echo sounder and sonar transducer cables may pass through the magazine provided that the run is continuous, i.e. without junction boxes. Where cables are exposed to the atmosphere outside the magazine they are to be enclosed in steel conduit within the magazine to protect against the effects of electro magnetic pulse (NEMP).~~

Existing paragraphs 6.8.8 & 6.8.9 are to be renumbered 6.8.5 & 6.8.6

~~*6.8.10*~~ *6.8.7* Equipment and light fixtures installed in magazines which may be subjected to mechanical damage are to be equipped with suitable protection against such damage. All protective metal guards for apparatus and cabling as well as the apparatus itself must be effectively earthed. Where required, ~~C~~conduit is to be electrically continuous and bonded to earth to form an effective shield.

6.9 Fire protection

6.9.1 Integral and small magazines are to be fitted with a spray system capable of rapid reaction, with manual ~~and automatic~~ activation and a suitable permanent drainage system.

~~*6.9.2* Spray systems for integral magazines may be activated by heat detectors (and smoke). Each of the detectors is to be independently capable of activating the system. Generally a minimum of three heat detectors are required in a magazine. They are to be distributed across the deckhead taking into account the layout of the magazine and relationship of the boundaries to the potential risk from adjacent compartment or area.~~

~~*6.9.3* Small magazines may be activated by a thermal detector head, for example a quartz bulb, provided that the system is primed at all times and an isolating valve is located adjacent to and outside the compartment.~~

~~*6.9.4* Missile canisters in silos may require high pressure water supply for local spray and deluge, in addition to the spray system required in 6.9.2 for drenching the exterior of the canister.~~

~~*6.9.5*~~ *6.9.2* The spray system is to be capable of delivering 30 litres/m^2/min. Large compartments ~~should~~ may be fitted with ~~several~~ independent spray systems covering separate areas.

~~*6.9.6*~~ *6.9.3* Spray heads are to be arranged within magazines so that all stowages and boundaries are covered when sprayed. ~~The designers calculations for hydraulic flow should be made available.~~

~~*6.9.7* Spray systems are to have a local and remote control station. The local and remote control position is to be provided with a manual override facility. The remote operating position is to be separated from the local position by at least one deck or a main watertight bulkhead. Where practicable, all remote operating positions should be sited in one location. For magazines containing International maritime dangerous goods (IMDG) class 1.1 munitions, (substances and articles that have a mass explosion hazard) where the NEQ is greater then 500 Kg an emergency operating position is to be located on the weather deck.~~

~~*6.9.8*~~ *6.9.4* Spray systems for integral magazines are to be fed from two separate sections of the ship's water supply.

~~*6.9.9*~~ *6.9.5* Magazine lockers and boxes are ~~generally~~ to be fitted with flood and drainage systems. The flood system is to be operated by a manual control adjacent to the locker but at least 5 m away or 3 m if suitably screened and fed from a pressurised water supply.

~~*6.9.10* Heat and smoke detectors are also required to activate audible and visible alarms both locally and remotely. The smoke and heat detectors are to be part of a type approved fire detection alarm system. In addition the heat detector operating temperature is not to be greater then 30°C above the maximum anticipated deck head temperature.~~

~~*6.9.11*~~ *6.9.6* Compartments other than tanks or void spaces adjacent to magazines are to be fitted with smoke or fire detectors.

~~*6.9.12*~~ *6.9.7* Locking arrangements are to be fitted to all spray, flooding, drain valves and cocks with the exception of ~~pneumatic~~ spray control valves when housed in a lockable cabinet.

Existing paragraph 6.9.13 is to be renumbered 6.9.8

~~6.9.14 Other areas at risk such as weapon lifts, transfer passages or weapon preparation areas are to be fitted with similar fire protection systems to the magazine.~~

~~*6.9.15*~~ *6.9.9* Designated danger areas (DDA) where munitions are handled such as weapon lifts, transfer passages, weapon preparation areas, hangars, flight decks, docks and RAS points are to be fitted with ~~manually operated spray systems and or hose points~~ similar fire protection systems to the magazine, commensurate with the risk classification and type of vessel. LR may allow system requirements to be reduced to the provision of sufficient hose points based on the risk classification.

~~*6.9.16* Munitions assessed as vulnerable to fuel fire are not to be stored adjacent to any aircraft, motor transport or fuelling points of either.~~

~~*6.9.17*~~ *6.9.10* Magazines are to be coated with fire resistant paint and the deck covering is to be non spark and non-slip. Any requirements for a conductive deck area and personnel will be identified in the armaments requirement, *see* ~~6.1.2~~. 6.1.3. Where there is a conducting deck requirement an anti-static precaution notice is to be displayed.

Volume 1, Part 5, Chapter 3

Local Design Loads

Effective date 1 January 2008

■ *Section 5*
Local design loads for decks and bulkheads

5.1 General

~~*5.1.4* Loads on decks and bulkheads due to magazine over pressure and magazine flooding are to be considered as defined by the Naval Authority, see Pt 4, Ch 1,6.4.~~

5.8 Design pressures for watertight and deep tank bulkheads and boundaries

5.8.1 The design normal pressure for bulkhead plating with stiffeners is to be considered separately for the plating and the stiffeners. The design normal pressure for the plating, P_{bhp}, is to be taken as follows:
(*Part only shown)*

where
ρ = density of fluid, in tonnes/m^3, and is not to be taken as less than 1,025

5.8.2 The design normal pressure for the stiffener, P_{bhs}, is to be taken as follows:
(Part only shown)
where
ρ = density of fluid, in tonnes/m^3, and is not to be taken as less than 1,025.

5.11 Design pressure for magazine decks and bulkheads

5.11.1 For magazine structure which is assessed in accordance with Pt 4, Ch 1,6.4 the quasi-static design pressure is to be taken as follows:

$$P_{mag} = 2,25 \left(\frac{W_e}{V}\right)^{0,72} \times 10^3 \quad \text{kN/m}^2$$

where
W_e = weapon equivalent weight of TNT, in kg
V = free compartment volume, in m^3.

5.11.2 For magazines below the limit of watertight integrity the design pressure, P_{mag}, is not to be taken as less than the design pressure for watertight bulkheads and boundaries, plating and stiffening, *see* 5.8.

Volume 1, Part 6, Chapter 2

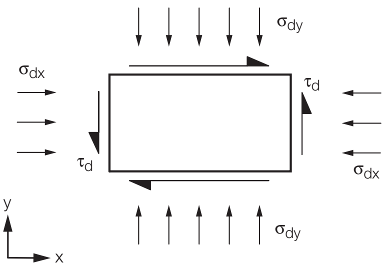
Design Tools

CORRIGENDA

■ *Section 4*

Buckling

Table 2.4.2 Plate panel buckling requirements (*Part only shown*)

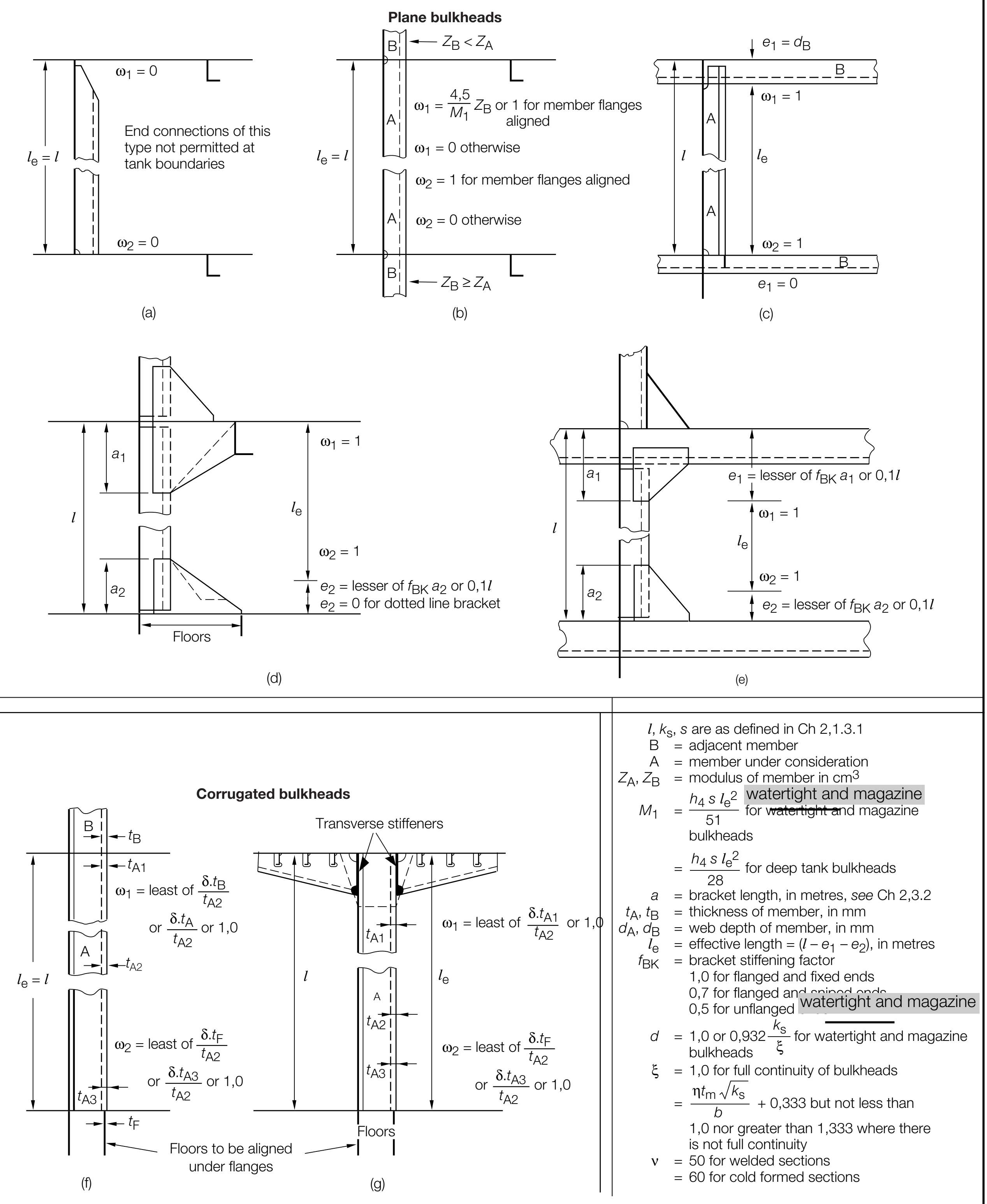
(e)	bi-axial compressive loads plus shear loads	$\dfrac{0{,}625\left(1+\dfrac{0{,}6}{A_{\text{R}}}\right)\left(\dfrac{\sigma_{\text{dy}}}{\sigma_{\text{cy}}}\right)}{\left(1-0{,}625\right)\left(\dfrac{\sigma_{\text{dx}}}{\sigma_{\text{cx}}}\right)}+\dfrac{\left(\dfrac{\tau_{\text{d}}}{\tau_{\text{c}}}\right)^{2}}{1-\left(\dfrac{\sigma_{\text{dx}}}{\sigma_{\text{cx}}}\right)}\leq 1$	

Volume 1, Part 6, Chapter 3
Scantling Determination

Effective date 1 January 2008

■ *Section 3*

NS1 scantling determination


Plane bulkheads
$\omega_1 = 0$
End connections of this type not permitted at tank boundaries
$l_e = l$
$\omega_2 = 0$
(a)
B
$Z_B < Z_A$
A
$\omega_1 = \frac{4,5}{M_1} Z_B$ or 1 for member flanges aligned
$\omega_1 = 0$ otherwise
$\omega_2 = 1$ for member flanges aligned
$\omega_2 = 0$ otherwise
$Z_B \geq Z_A$
(b)
$e_1 = d_B$
$\omega_1 = 1$
l
l_e
$\omega_2 = 1$
$e_1 = 0$
(c)
a_1
a_2
$\omega_1 = 1$
$\omega_2 = 1$
e_2 = lesser of $f_{BK}\, a_2$ or $0,1l$
$e_2 = 0$ for dotted line bracket
Floors
(d)
e_1 = lesser of $f_{BK}\, a_1$ or $0,1l$
e_2 = lesser of $f_{BK}\, a_2$ or $0,1l$
(e)
Corrugated bulkheads
t_B
t_{A1}
t_{A2}
t_{A3}
t_F
ω_1 = least of $\frac{\delta . t_B}{t_{A2}}$ or $\frac{\delta . t_A}{t_{A2}}$ or 1,0
ω_2 = least of $\frac{\delta . t_F}{t_{A2}}$ or $\frac{\delta . t_{A3}}{t_{A2}}$ or 1,0
Floors to be aligned under flanges
(f)
Transverse stiffeners
ω_1 = least of $\frac{\delta . t_{A1}}{t_{A2}}$ or 1,0
ω_2 = least of $\frac{\delta . t_F}{t_{A2}}$ or $\frac{\delta . t_{A3}}{t_{A2}}$ or 1,0
Floors
(g)

l, k_s, s are as defined in Ch 2,1.3.1

B = adjacent member

A = member under consideration

Z_A, Z_B = modulus of member in cm^3

watertight and magazine

M_1 = $\frac{h_4 s l_e^2}{51}$ for ~~watertight a~~nd magazine bulkheads

= $\frac{h_4 s l_e^2}{28}$ for deep tank bulkheads

a = bracket length, in metres, *see* Ch 2,3.2

t_A, t_B = thickness of member, in mm

d_A, d_B = web depth of member, in mm

l_e = effective length = ($l - e_1 - e_2$), in metres

f_{BK} = bracket stiffening factor
1,0 for flanged and fixed ends
0,7 for flanged and sniped ends
0,5 for unflanged

watertight and magazine

d = 1,0 or $0,932 \frac{k_s}{\xi}$ for watertight and magazine bulkheads

ξ = 1,0 for full continuity of bulkheads

= $\frac{\eta t_m \sqrt{k_s}}{b} + 0,333$ but not less than 1,0 nor greater than 1,333 where there is not full continuity

ν = 50 for welded sections

= 60 for cold formed sections

Fig. 3.3.3 Bulkhead end constraint factors

Fig. 3.3.3 Bulkhead end constraint factors

Table 3.3.7 **Deck longitudinals (longitudinal framing)**

Symbols

[Part only shown]
h_2 = deck pressure head (*see* Note 4)
= 2,6 for machinery spaces, workshops or hangers
= 2,0 for stores
= 1,2 for accommodation decks and void spaces
= h_m for general cargo spaces
h_m = general cargo deck pressure head, to be taken as equivalent to the pressure head produced by filling the hold to its full depth at a stowage rate of 1,39m^3/tonne, unless specified otherwise (*see* Note 6).

NOTES
6. If the hold does not have a uniform cross-section the breadth and/or length averaged over the averaged depth, to an equivalent rectangular section, may be used when determining the volume of the hold.

Table 3.3.15 Magazine bulkhead and deck scantlings

Item and requirement	Magazine bulkheads and decks
Plating	
1) Plating thickness for plane, symmetrically corrugated and double plate bulkheads	$t = 0{,}004 s\beta\sqrt{h_5 k_5}$ mm
Secondary stiffening	
(2) Modulus of rolled and built stiffeners	$Z = \dfrac{s k_s h_5 l_e^2}{71 f_s (\omega_1+\omega_2+2)}$ cm^3
Primary stiffening	
(3) Modulus of stringers or webs supporting vertical or horizontal stiffening	$Z = 5{,}0 k_s h_5 S l_e^2$ cm^3

Symbols

s, S, k_s as defined in Table 3.2.1
l_e = effective length of stiffening member in metres and for bulkhead stiffeners, *see* Fig. 3.3.3
f_s = 1,4 for rolled or built sections and double plate bulkheads
= 1,6 for flat bars
= 1,0 for symmetrical corrugations of magazine bulkheads
h_5 = $0{,}1P_{mag}$
P_{mag} is the quasi-static design pressure defined in Pt 5, Ch 3,5.11

$\omega 1$ and $\omega 2$ are bulkhead end constraint factors, *see* Fig. 3.3.3
β = aspect ratio correction factor, *see* Ch 2,2..5.1

NOTES
Corrugated bulkheads are to comply with the requirements of Ch 2,2.3. Both the plate panels and section inertia and modulus requirements are to be assessed.

3.16 Magazine structure

3.16.1 Magazine structure which is assessed in accordance with Pt 4, Ch 1,6.4 is to comply with the requirements of Table 3.3.15.

■ *Section 9*
Bulkheads and deep tanks

9.6 Wash plates

9.6.4 The area of perforation is to be not less than 5 per cent and not more than 10 per cent of the total area of the bulkhead.

■ *Section 14*
Strengthening for bottom slamming

14.2 Strengthening of bottom forward

14.2.8 For ~~NSI~~ NS1 ships where C_b <0,6 and for NS2 and NS3 ships, the equivalent bottom impact pressure head, h_s, is to be derived in accordance with the following: ~~The equivalent slamming pressure head, hs, is to be derived from the instantaneous bottom impact pressure IPbi, see Pt 5, Ch 3,4.2.~~

~~$h_s = \frac{f_{DLF} IP_{bi}}{10}$ m~~

$$h_s = \frac{IP_{bi}}{10} \text{ m}$$

where

~~f_{DLF} is the dynamic load derived from the plating or the stiffener/plate combination as appropriate, see Ch 2,6. The duration t_1 is given as follows:~~

~~$t_1 = 2t_r$ seconds~~

~~where~~

~~t_r is the rise time given in Pt 5, Ch 3,4.2.~~

IP_{bi} = instantaneous bottom impact pressure as given in Pt 5, Ch 3,4.2

■ *Section 15*
Strengthening for wave impact loads above waterline

15.2 Strengthening against bow flare wave impacts

15.2.2 The equivalent bow flare wave impact head, h_s, is to be taken as:

~~$h_s = \frac{f_{DLF} IP_{bf}}{10}$ m~~

$$h_s = \frac{IP_{bf}}{10} \text{ m}$$

where

IP_{bf} is the bow flare or above waterline wave impact pressure, *see* Pt 5, Ch 3,4.3.

~~f_{DLF} is the dynamic load derived from the plating or the stiffener/plate combination as appropriate, see Ch 2,6. The duration t_1 is given as follows:~~

~~$t_1 = 2t_r$ seconds~~

~~where~~

~~t_r is the rise time given in Pt 5, Ch 3,4.3.~~

~~15.2.5~~ 15.2.4 The scantlings of primary members are not to be less than:

(Part only shown)

(c) The web of the primary member is to be adequately stiffened.

(Part only shown)

~~15.2.4~~ 15.2.5 The scantlings of secondary stiffeners are not to be less than:

(a) ~~Section modulus of secondary stiffeners~~ Effective plastic section modulus of stiffeners:

~~$Z = \frac{h_s s_{cm} k_s l_e^2}{483}$ cm^3~~

$$Z_p = 3{,}75 h_s\, s_{cm}\, k_s\, l_e^2 \text{x} 10^{-3} \text{ cm}^3$$

where

h_s = wave impact head, in metres, as defined in 15.2.2

s_{cm} = mean spacing of secondary stiffeners, in mm, measured along a chord between parallel adjacent members or equivalent supports, as shown in Fig. 3.15.1

15.2.6 The effective section properties of secondary stiffeners are to be taken as:

(a) Plastic section modulus of secondary stiffeners, Z_p is to be taken as:

$$Z_p = (2{,}8 \text{ x } 10^{-4}\, s_{cm}\, t_p^2) - (10^{-3}\, b_f\, b_{fc}\, t_f \sin\theta_e) + (5 \text{ x } 10^{-4}\, (h_w^2\, t_w + 2b_f\, t_f\, h_w) \cos\theta_e) \text{ cm}^3$$

where

θ_e = C_o (90 - φ)

C_o = 1,1

φ = the angle between the stiffener and the side shell, in degrees

b_{fc} = 0,5(b_f - t_w) for L profiles

= 0 for flat bar and T profiles

= *see* Fig. 2.2.1 in Pt 6, Ch 2, for bulb profiles

h_w = height of web, in mm

t_w = web thickness, in mm

b_f = breadth of flange, in mm

t_f = flange thickness, in mm

t_p = thickness of attached plating, in mm

s_{cm} = defined in 15.2.5.

(b) Web area of secondary stiffeners, A_s is to be taken as:

A_s = 0,01 (h_w + t_p) t_w sinφ cm^2

Existing paragraphs 15.2.6 to 15.2.8 are to be renumbered 15.2.7 to 15.2.9.

~~15.2.9~~ 15.2.10 ~~For stiffeners and primary structure where~~ Where the angle between the ~~stiffener~~ primary structure web and the plating is less than 70°, the effective section modulus and shear area are to take account of the non-perpendicularity.

Existing paragraph 15.2.10 is to be renumbered 15.2.11

Volume 1, Part 6, Chapter 6

Material and Welding Requirements

Effective date 1 January 2008

■ *Section 4*
Welded joints and connections

Table 6.4.1 Weld factors

Item	Weld factor	Remarks
[*Part only shown*]		
~~Machinery rafts~~		
Raft seatings	0,27	
Weapon seatings	0,44	full penetration welding may be required

Volume 2, Part 1, Chapter 1

General Requirements for Classification of Engineering Systems

Effective date 1 January 2008

■ *Section 4*
Engineering system classification principles

4.6 Through life operation principles

4.6.7 Operating and maintenance manuals for all engineering systems are to be provided on board and are to include the following information:

(a) Particulars of engineering systems.

(b) Operating instructions for all engineering systems including recommended continuous operating design limits.

(c) Maintenance instructions for engineering systems and equipment.

(d) Instructions for normal and reversionary modes of operation for machinery and equipment in mobility and ship type engineering systems, *see* Ch 2,3.3.19.

■ *Section 6*
Routes to conformance

6.2 Machinery to be constructed under survey

(Part only shown)

6.2.1 All major units of equipment within the Mobility category and where specifically required within the Ship Type category and Ancillary category, are to be individually surveyed at the manufacturer's works or meet the requirements of the Quality Assurance Scheme for Machinery. The workmanship is to be to the Surveyor's satisfaction and the Surveyor is to be satisfied that the components are suitable for the intended purpose and duty. Examples of such units are:

- Main propulsion prime movers (oil engines, gas turbines and steam turbines) including their associated gearing, flexible couplings and turbochargers as applicable.
- Boilers supplying steam for propulsion or for services essential for the safety or the operation of the ship at sea, including superheaters, economizers, desuperheaters, steam heated steam generators and steam receivers. All other boilers having working pressures exceeding 3,4 bar and having heating surfaces greater than 4,65 m^2.
- Auxiliary engines which are the source of power for services essential for safety or for the operation of the ship at sea.
- Steering machinery.
- Athwartship thrust units, their prime movers and control mechanisms.
- All pumps necessary for the operation of main propulsion and essential machinery, e.g. boiler feed, cooling water circulating, condensate extraction, oil fuel and lubricating oil pumps.
- All heat exchangers necessary for the operation of main propulsion and essential machinery, e.g. air, water and lubricating oil coolers, oil fuel and feed water heaters, deaerators and condensers, evaporators and distiller units.
- Air compressors, air receivers and other pressure vessels necessary for the operation of main propulsion and essential machinery. Any other unfired pressure vessels for which plans are required to be submitted as detailed in Pt 8, Ch 2.
- All pumps essential for safety of the ship, e.g. fire, bilge and ballast pumps~~, exceeding 7 bar~~.
- Valves and other components intended for installation in essential piping systems, *see* Pt 7, Ch 1,2.2.1 having working pressures exceeding 7 bar.
- Alarm and control equipment as detailed in Pt 9, Ch 1.
- Electrical equipment and electrical propelling machinery as detailed in Pt 10, Ch 1.

Volume 2, Part 1, Chapter 2

Requirements for Design, Construction, Installation and Sea Trials of Engineering Systems

Effective date 1 January 2008

■ *Section 3*
Particulars to be submitted

3.3 Calculations and specifications

3.3.18 **Operation of machinery outside its recommended continuous operating design envelope**. Where equipment and machinery installed in mobility and ship type engineering systems may be required to operate for continuous periods outside its recommended continuous operating design envelope, details of the intended operating conditions, time intervals and frequency of use together with documentary evidence indicating the suitability of the design and any limitations under these conditions are required to be submitted. Arrangements may include time alongside, manoeuvring, close-down and other military operations or trials. The following items of machinery and equipment are to be considered:

(a) Prime mover(s);
(b) Gearbox(s);
(c) Steering systems;
(d) Bearings;
(e) Couplings;
(f) Vibration dampers;
(g) Shafting and related power and propulsion transmission items;
(h) Other items of machinery and equipment in mobility and ship type engineering systems as identified and agreed between the owner/operator and builder;

The manufacturer's requirements and recommendations for operation and maintenance are to be addressed with provision as necessary of documentation such as manuals and warnings with particular reference to lubrication and cooling systems and any predicted adverse affects e.g. fouling. As far as practicable, the specification, selection and arrangements of machinery and equipment are to be agreed between the shipbuilder and Owner/Operator for foreseeable operating conditions.

3.3.19 **Training and drill regimes**. Where training and testing regimes for machinery capability and availability, reversionary modes of operation and breakdown drills have been identified by the owner/operator, full details of the intended regimes are required to be submitted in order to ascertain that the reliability of the machinery and associated systems is not significantly affected. The following are to be considered as applicable and included in the operating and maintenance manuals:

(a) Machinery repair breakdown drills;
(b) Post up-keep trials/Routine assessment trials;
(c) Simulating fault conditions;
(d) Rapid ship manoeuvres;
(e) Electrical equipment and system configuration drills;
(f) Damage control and work-up exercises.

As far as practicable, the specification, selection and arrangements of machinery and equipment are to be agreed between the shipbuilder and Owner/Operator for foreseeable training and drill regimes.

■ *Section 4*
Operating conditions

4.1 Availability for operation

4.1.5 Installed machinery is to be capable of operating satisfactorily in accordance with the manufacturer's stated operating conditions within an operational envelope specified for the ship by the Owner/Operator and agreed by the manufacturer/system designer, *see* 3.3.18. The optimum operational envelope is where machinery and equipment is operated to provide its best performance without causing undue wear or deterioration that could affect its operational reliability.

4.1.6 Installed machinery is to be capable of operating satisfactorily in accordance with the manufacturer's stated operating conditions within defined training and drill regimes specified by the Owner/Operator and agreed by the shipyard and machinery/equipment manufacturer, *see* 3.3.19.

4.4 Ambient reference conditions

4.4.1 The rating for classification purposes of main and essential auxiliary machinery intended for installation in naval sea-going ships to be classed for unrestricted (geographical) service is to be based on:

- A total barometric pressure of 1000 mb
- An engine room ambient temperature or suction air temperature of 45ºC.
- A relative humidity of 60 per cent.
- Sea-water temperature or, where applicable, the temperature of the charge air coolant at the inlet of 32ºC.

NOTE
The engine manufacturer is not expected to provide simulated ambient reference conditions at a test bed.

Volume 2, Part 1, Chapter 2 & Volume 2, Part 2, Chapter 1

Effective date 1 January 2007

4.14 Machinery interlocks

4.14.1 Interlocks are to be provided to prevent ~~starting~~ any operation of engines, turbines or applicable auxiliary machinery under conditions that could hazard the machinery or personnel. These are to include 'turning gear engaged', 'low lubricating oil pressure', where oil pressure is essential for the prevention of damage during start up, 'shaft brake engaged' and where machinery is not available due to maintenance or repairs. The interlock system is to be arranged to 'fail safe'.

4.14.2 In the case of machinery with manual turning gear which is not permanently attached, warning devices or notices may be provided as an alternative to interlocks as required by 4.14.1.

Volume 2, Part 2, Chapter 1

Diesel Engines

Effective date 1 January 2007

■ *Section 1*

General requirements

1.6 Turning gear

1.6.1 Turning gear is to be provided for all engines to facilitate operating and maintenance regimes as required by the manufacturer. Manuals are to be provided and are to comply with the requirements of Pt 1, Ch 1,4.6.7.

1.6.2 The turning gear for all propulsion engines is to be power-driven and if electric, is to be continuously rated.

1.6.3 The turning gear for auxiliary engines may be hand operated (manual) except where this is not practicable, in which case the provision of 1.6.2 is to be complied with.

1.6.4 The turning gear for all engines is to be fitted with safety Interlocks which prevent engine operation when engaged *see* Pt 1, Ch 2,4.13. Indication of engaged/disengaged is to be provided at all start positions. In the case of unattached hand operated turning gear engine operation may be prevented by manual means including the provision of warning devices or notices.

1.6.5 The remote control device of power-driven turning gear is to be so designed that power is removed from the turning gear when the operating switch is released.

1.6.6 Means are to be provided to secure the turning gear when disengaged.

1.6.7 Overload protection arrangements are to be provided to prevent damage to the electric motor and the turning gear train.

Effective date 1 January 2008

■ *Section 9*

Control and monitoring

9.8 Auxiliary and other engines

Table 1.9.2 Auxiliary diesel engines: Alarms and shutdowns
(*Part only shown*)

Item	Alarm	Note
Exhaust gas temperature	High	Per cylinder. ~~f~~For engine power ~~>~~ <500 kW/cylinder, common sensors for each inlet to the turbocharger may be accepted See Note 1
NOTE 1. The arrangements are to comply with the requirements of the Naval Authority concerned.		

■ *Section 11*

Mass produced engines

11.5 Type test conditions

11.5.11. The rated output for which the engine is to be tested is the output corresponding to that declared by the manufacturer and agreed by LR, i.e. actual maximum power which the engine is capable of delivering continuously between the normal maintenance intervals stated by the manufacturer at the rated speed and under the stated ambient conditions. *See* Vol 2, Pt 1, Ch 2,4.4.1.

Volume 2, Part 2, Chapter 2

Gas Turbines

Effective date 1 January 2007

■ *Section 1*

General requirements

1.6 Turning gear

1.6.1 Gas generator turning gear is to be provided to facilitate operating and maintenance regimes as required by the manufacturer. Manuals are to be provided and are to comply with the requirements of Pt 1, Ch 1,4.6.7.

1.6.2 The turning gear may be hand operated (manual) except where this is not practicable. If electrically driven, the motor is to be continuously rated.

1.6.3 The turning gear is to be fitted with safety interlocks which prevent engine operation when engaged, *see* Pt 1, Ch 2,4.13. Indication of engaged/disengaged is to be provided at all start positions. In the case of hand operated turning gear turbine, operation may be prevented by manual means including the provision of warning devices or notices.

1.6.4 The remote control of power driven turning gear is to be designed so that power is removed if the operating switch is released.

1.6.4 If permanently attached, means are to be provided to secure the turning gear when disengaged.

1.6.6 Overload protection arrangements are to be provided to prevent damage to the electric motor and the turning gear train.

Volume 2, Part 2, Chapter 3

Steam Turbines

Effective date 1 January 2007

■ *Section 4*

Design and construction

4.8 Turning gear

4.8.1 Turning gear is to be provided for all turbines to facilitate operating and maintenance regimes as required by the manufacturer. Manuals are to be provided and are to comply with the requirements of Pt 1, Ch 1,4.6.7.

~~4.8.1~~ *4.8.2* The turning gear for all propulsion turbines is to be power-driven and if electric, is to be continuously rated.

4.8.3 The turning gear for all turbines is to be fitted with safety interlocks which prevent steam valve actuation for turbine operation when engaged, *see* Pt 1, Ch 2,4.13. Indication of engaged/disengaged is to be provided at all start positions. In the case of hand operated turning gear turbine operation may be prevented by manual means including the provision of warning devices or notices.

4.8.4 The remote control of power driven turning gear is to be designed so that power is removed if the operating switch is released.

4.8.5 Means are to be provided to secure the turning gear when disengaged.

4.8.6 Overload protection arrangements are to be provided to prevent damage to the electric motor and the turning gear train.

Volume 2, Part 7, Chapter 1

Piping Design Requirements

Effective date 1 January 2008

■ *Section 5*

Pipe connections

5.2 Flange connections

5.2.2 Gaskets are to be suitable for the conveyed fluids under design pressure and temperature conditions and their dimensions and configuration is to be in accordance with recognised standards. Gasket materials used in oil piping systems are to be impervious to oil and the thinnest possible~~.~~ as determined from manufacturer's recommendations that the flange arrangement will allow, to ensure the minimum loss of bolt stress due to gasket relaxation.

Volume 2, Part 7, Chapter 3
Machinery Piping Systems

Effective date 1 January 2008

■ *Section 1*
General requirements

1.2 Plans and particulars

1.2.1 Three copies of the following plans (in diagrammatic form) and particulars are to be submitted for approval. Additional plans should not be submitted unless the arrangements are of novel or special character affecting classification.

- Arrangements of oil fuel bunkering, storage and transfer.
- Arrangements of oil fuel piping in connection with oil burning installations.
- Arrangements of oil fuel burning units for boilers and thermal fluid heaters.
- Arrangements of any gas burning installations.
- Arrangement of boiler feed system.
- Arrangements of thermal fluid circulation systems.
- Arrangement of compressed air systems for main and auxiliary services.
- Arrangements of lubricating oil systems.
- Arrangements of flammable liquids used for power transmission, control and heating systems.
- Arrangements of non-flammable liquids used for power transmission and control systems in Mobility category and Ship Type category engineering systems.
- Arrangements of cooling water systems for main and auxiliary purposes.
- Oil fuel settling service and other oil fuel tanks not forming part of the ship's structure.
- Arrangements of steam systems for main and auxiliary services.
- Arrangements of incinerator systems.
- Arrangements of air intakes and exhaust gas piping for main and auxiliary machinery.
- Description of oil fuels with statement of minimum flash point (closed cup test).
- Arrangements and dimensions of all steam and thermal fluid pipes where the design pressure or temperature exceeds 16,0 bar (16,3 kgf/cm^2) or 300°C, respectively, and the outside diameter exceeds 76,1 mm, with details of flanges, bolts and weld attachments, and particulars of the material of pipes, flanges, bolts and electrodes.

■ *Section 3*
Oil fuel burning arrangements

3.1 Oil burning units

3.1.1 Where steam ~~or thermal oil~~ is required for the main propelling engines, or where steam or thermal fluid is required for auxiliary machinery for essential services, or for heating of heavy oil fuel and is generated by burning oil fuel under pressure, there are to be not less than two oil burning units, ~~each unit comprising a pressure pump, a suction filter, a discharge filter and a heater~~. For auxiliary boilers and thermal oil heaters, a single oil burning unit may be accepted, provided that alternative means, such as an exhaust gas heated boiler or heater, are available for supplying steam or thermal ~~oil~~ fluid for essential purposes.
Where the oil burning unit is not of the monobloc type (i.e. separate register and oil supply unit) each oil burning unit is to comprise of a pressure pump, suction filter, discharge filter and, when required, a heater.

~~*3.1.2.* In two unit installations, each unit is to be capable of supplying fuel for generating all the steam or supplying all the thermal oil required for essential services.~~

~~*3.1.3.* In installations of three or more units, the capacities and arrangements of the units are to be such that all the steam or thermal oil required for essential services can be maintained with any one unit out of action.~~

3.1.2 Where steam or thermal fluid is required to provide essential services, the number, arrangement and capacity of oil burning units is to be capable of supplying sufficient fuel to allow the steam or thermal fluid required to provide essential services to be generated with any one unit out of action.

~~*3.1.4*~~ *3.1.3* Unit pressure pumps are to be entirely separate from the feed, bilge or ballast systems.

3.1.4 In dual oil fuel burning systems for boilers which are primarily designed for operation with residual oil fuel grades, arrangements are to be such that atomising steam cannot be used in combination with distillate oil fuel grades.

3.1.5 Whenever the oil fuel burning units are stopped, shut-off arrangements for oil fuel to the units are to be provided as follows:

(a) If the supply oil fuel is under pressure during shut-off to oil burning units, duplicated shut-off valves in series are to be fitted. Cocks are to be fitted to allow manual testing for leakage from each of the valves in the installed condition, they are to be capable of being locked in the closed position and any discharges are to be led to a safe position to ensure that discharge of oil through the test cocks does not present an ignition hazard.

(b) If arrangements are such that oil fuel pressure is released through drainage during oil fuel shut-off to oil burning units, a single shut-off device may be accepted subject to approval by LR.

3.1.6 When combined air and fuel/steam/air combustion systems are used for multiple boiler installations, they are to be such that single boiler operation will not be adversely affected by the operation of another boiler system at any time.

3.1.7 Arrangements are to be such that furnace pre-purging is completed prior to any burner ignition sequence. The purge time is to be based on a minimum of 4 air changes of the combustion chamber, furnace and uptake spaces. The purge timing is to take account of the air flow rate and the sequence is not to commence until all air registers and dampers as applicable are fully open and the forced draft fans are operating.

3.1.8 The effect of multiple light-off failures is to be assessed and the need to lock out further ignition sequences established.

3.1.9 Means are to be provided so that, in the event of flame failure, the oil fuel supply to the burner(s) is shut-off automatically, and an alarm is given, *see* 9.3 and 9.4, and Pt 8, Ch 1,18 as applicable.

3.1.10 It is to be demonstrated to the Surveyor's satisfaction during trials that burner shut-off times due to flame failure comply with the following requirements and details of the procedures and means used to set this time interval are to be submitted for consideration:

(a) The time interval at burner start up between the burner oil fuel valve(s) being opened and then closed in the event of flame failure is to be long enough to allow a stable flame to be established and detected under normal operational circumstances but is to be set to minimise the quantity of oil fuel delivered to the furnace and the possibility of subsequent damage as a result of unintended ignition.

(b) The time interval between flame failure detection and closing of burner oil fuel valve(s) is to be long enough to prevent shut-down due to incorrect detection of a flame failure under normal operational circumstances but is to be set to minimise the quantity of unburned oil fuel delivered to the furnace and the possibility of subsequent damage as a result of unintended ignition.

3.1.11 A warning notice is to be fitted in a prominent position at every oil burning unit local manual control station which specifies that burners operated with manual or local overrides in use are only to be ignited after sufficient purging of the furnace and of any additional precautions required when operating in this condition.

~~3.7 Top-fired boilers - Flame failure~~

~~*3.7.1* In the case of top-fired boilers, means are to be provided so that, in the event of flame failure, the oil fuel supply to the burners is shut-off automatically, and audible and visual warnings are given. Any proposal to depart from this requirement in the case of small auxiliary top-fired boilers will be specially considered.~~

Existing sub-Sections 3.8 to 3.12 are to be renumbered 3.7 to 3.11

■ *Section 4*

Oil fuel pumps, pipes, fittings, tanks, etc.

4.5 Pipes conveying heated oil

~~*4.5.2* Where pipes convey heated oil under pressure the flanges are to be machined, and the jointing material, which is to be impervious to oil heated to 150ºC, is to be the thinnest possible, so that flanges are practically metal to metal. The scantlings of the pipes and their flanges are to be suitable for a pressure of at least 13,7 bar or for the design pressure, whichever is the greater.~~

4.5.2 Where pipe systems convey heated oil under pressure and include flanged joints, the flanges and joints are to be suitable for a design pressure of at least 13,7 bar (14 kgf/cm^2) or the design pressure, whichever is the greater and a design temperature of 150ºC or the design temperature whichever is the greater. They are to comply with a relevant and acceptable National or International Standard, and the requirements of Pt 7, Ch 1 at the defined temperature and pressure. Materials for the pipes, flanges and gaskets are to be suitable for the conveyed medium at the defined temperature and pressure.

■ *Section 9*

Control, supervision and monitoring of equipment

9.3 Thermal fluid heaters

9.3.1 Alarms and safeguards are indicated in 9.3.2~~, 9.3.3~~ to 9.3.8, and Table 3.9.1.

9.3.2 The standby pumps for oil fuel and thermal fluid circulation are to start automatically when the discharge pressure from the working pump falls below a predetermined value. The standby pumps for thermal fluid circulation are to start before the shut-offs due to low thermal fluid pressure, *see* Table 3.9.1, are activated.

9.3.4 Burner controls are to be arranged such that light-off is only possible at the minimum firing rate compatible with flame establishment. If ignition is set to occur at a fuel rich condition the burner is to revert to the correct operating air/fuel ratio on establishment of a stable flame.

9.3.5 Burner oil fuel valve(s) are not to open:

- prior to completion of required warm up times; or
- when the power supply to the igniter has failed; or
- prior to the completion of furnace purging, *see* Pt 7, Ch 3,3.1.7.

9.3.6 Arrangements for flame failure detection are to be provided with self-monitoring capabilities which prove that the flame detector is not erroneously indicating the presence of a flame. In the event of failure being detected by these self-monitoring capabilities:
- oil fuel to burner is to be shut-off automatically; and
- an alarm is to be activated.

9.3.7 Where established as necessary by Pt 7, Ch 3,3.1.8 means are to be provided to prevent starting of the ignition sequence following multiple flame failures until completion of the identified lock out period.

9.3.8 Following burner shut-down, the furnace is to be purged automatically for at least the required pre-purging time. In event of shutdown due to activation of a required safeguard this purging is to be manually initiated.

Table 3.9.1 Thermal fluid heaters: Alarms and safeguards

Item	Alarm	Note
Expansion tank level*	Low	Oil fuel burners to be shut off automatically
Thermal fluid flow	Low	Oil fuel burners to be shut off automatically
Thermal fluid pressure	Low	Oil fuel burners to be shut off automatically
Thermal fluid outlet temperature*	1st stage High	—
	2nd stage High	Oil fuel burners to be shut off automatically~~. S~~, *see* 9.2.3
Combustion air pressure*	Low	Oil fuel burners to be shut off automatically, *see* Note 3
Oil fuel pressure*	Low	—
Oil fuel temperature or viscosity*	High and low	Heavy oil only
Oil fuel atomizing steam/air pressure	Low	—
Burner flame* ~~and ignition~~	Failure	Each burner to be monitored. Oil fuel to burners to be shut off automatically~~. S~~ , *see* 3.1.9 to 3.1.10, and Note ~~1~~ 3
Flame monitoring device(s)*	Failure	*See* 9.3.6 and Note 3
Igniter*	Failure	Each igniter to be checked before oil is supplied to burner, *see* 9.3.5 and Note 3
Forced draft fan*	Power failure	Oil fuel burners to be shut off automatically, *see* Note 3
Air register and dampers (including those in the uptake)*	Not fully open	Purge sequences to be inhibited, *see* 3.1.7
Control system*	Power failure	Oil fuel to burners to be shut-off automatically. Control using alternative arrangements is to remain available, *see* Pt 9, Ch 1,2.5.7.
Uptake temperature	High	Where applicable, to monitor for soot fires

NOTES
~~1.~~ ~~Combustion spaces are to be purged automatically before re-ignition takes place in the event of a flame out on all burners.~~
~~2~~.1 Special consideration may be given to the requirements for oil fired hot water heaters.
2. For heaters not supplying thermal fluid for services essential for the safety or the operation of the ship at sea, only the items marked* are required.
3. These safeguards are to remain operative during automatic, manual and emergency operation.

9.5 Miscellaneous machinery

9.5.5 **Oil fuel tanks**. Means are to be provided to eliminate the possibility of overflow from ~~daily service~~ oil fuel service tanks into the machinery space and to safeguard against overflow of oil from ~~the daily service~~ oil fuel service tanks through the air pipe. *See* Pt 7, Ch 2 regarding the termination of air pipes.

Table 3.9.3 Miscellaneous machinery: Alarms and safeguards (*Part only shown*)

Item	Alarm	Note
~~Daily~~ Oil fuel service ~~oil fuel~~ tanks level	High and Low	~~One~~ Where a common overflow tank is fitted, a high level alarm in the common overflow tank may be ~~fitted in a common overflow tank~~ accepted
~~Daily~~ Oil fuel service ~~oil fuel~~ tanks temperature	High	Where heating arrangements are fitted

Volume 2, Part 7, Chapter 5

Ship Type Piping Systems

Effective date 1 January 2008

■ *Section 1*

General requirements

1.2 Scope

1.2.2 Other systems defined as Ship Type category engineering systems, *see* Pt 1, Ch 1,3.1.3, as identified by the Naval Authority.

Volume 2, Part 8, Chapter 1

Steam Raising Plant and Associated Pressure Vessels

Effective date 1 January 2008

■ *Section 1*

General requirements

1.6 Plans

1.6.3 Plans, in triplicate, showing details of the air flow through the combustion chamber, boiler furnace and boiler uptake spaces, including measures taken to assure effective purging in all of the spaces, are to be submitted for consideration, *see also* 18.2 and Pt 7, Ch 3, 9.3.

1.6.4 Plans, in triplicate, showing all areas of refractory in the combustion chamber and boiler furnace spaces, are to be submitted for consideration, *see* 1.12.1.

1.6.5 Calculations, in triplicate, that show a minimum of 4 air changes of the combustion chamber, boiler furnace and boiler uptake spaces will be achieved during automatic purging operations, with details of the forced draft fans and arrangements of air flow from fan intake to flue outlet, are to be submitted for consideration, *see* 1.12.1.

1.6.6 Calculations, in triplicate, that show that the ventilation of machinery spaces containing boilers is adequate for the air consumers within the space and unrestricted air supply to the items of plant is ensured under operating conditions.

1.12 Furnace explosion prevention

1.12.1 The design of combustion chamber and furnace arrangements is to incorporate measures to minimise the risk of explosion as far as practicable. Measures are to be taken to prevent the accumulation of flammable gases in spaces which may not effectively be reached by purging air. Measures are to be taken to minimise heat retaining surfaces e.g. refractory which can become a source of ignition in the furnace and uptakes.

Section 18
Control and monitoring

18.2 Automatic and remote controls

18.2.1 Where a boiler is fitted with automatic or remote controls so that under normal operating conditions it does not require normal intervention by the operators, it is to be provided with alarms and safety arrangements required by 18.2.2 to ~~18.2.5~~ 18.2.10, and Table 1.18.1.

18.2.4 Safety systems and overrides are to comply with the requirements of Pt 9, Ch 1, 2.4.8.

~~*18.2.4*~~ *18.2.5* Burner controls are to be arranged such that light off is only possible at the minimum firing rate compatible with flame establishment. If ignition is set to occur at a fuel rich condition the burner is to revert to the correct operating air/fuel ratio on establishment of a stable flame.

~~*18.2.5*~~ *18.2.6* Where water level indicators are dependent upon an external power supply, the oil fuel supply to the burners is to be automatically shut off in the event of power or signal failure.

18.2.7 Burner oil fuel valve(s) are not to open:

- prior to completion of required warm up times; or
- when the power supply to the igniter has failed; or
- prior to the completion of furnace purging, *see* Pt 7, Ch 3,3.1.7.

18.2.8 Arrangements for flame failure detection are to be provided with self-monitoring capabilities which prove that the flame detector is not erroneously indicating the presence of a flame. In the event of failure being detected by these self-monitoring capabilities:
- oil fuel to the burner is to be shut-off automatically; and
- an alarm is to be activated.

18.2.9 Where established as necessary by Pt 7, Ch 3,3.1.8 means are to be provided to prevent starting of the ignition sequence following multiple flame failures until completion of the identified lock out period.

18.2.10 Following burner shut-down, the furnace is to be purged automatically for at least the required pre-purging time. In event of shutdown due to activation of a required safeguard this purging is to be manually initiated.

Table 1.18.1 Boilers: Alarms and safeguards (*see* continuation)

Item	Alarm	Note
Water level*	Low	Two water level sensors are to be provided each to operate independently, and automatically shut off the oil fuel to the burners and operate alarms, *see* Notes 1 to 3, and Note 5
~~Water level*~~	1st stage high*	
Water level	2nd stage high	Where applicable; ~~A~~ automatic closure of turbine steam inlet valves, *see* 18.2.2
Steam drum or superheater outlet pressure	High and low	—
Superheated steam temperature	High	—
De-superheated steam temperature*	High	—
Feed water forced circulation flow (if fitted)	Low	Oil fuel to burners to be shut off automatically, *see* Note 5
Feed water pH	Low	When automatic dosing of feed water fitted
Feed water salinity	High	Fitted in boiler feed system
Feed water temperature	Low	When automatic temperature control fitted
Combustion air pressure*	Low	Oil fuel to burners to be shut off automatically, *see* Note 5
Oil fuel pressure*	Low	—
Oil fuel temperature or viscosity*	High and low	Heavy oil only
Oil fuel atomising steam/air pressure	Low	—
Burner flame*	Failure	Each burner to be monitored. Oil fuel to burner(s) to be shut off automatically, ~~S~~*see* Pt 7, Ch 3,3.1.9 and 3.3.10, and Note ~~4~~ 5
Flame monitoring device(s)*	Failure	*See* 18.2.8 and Note 5
Igniter*	Failure	Each igniter to be checked before oil is supplied to burner(s), *see* Note 5
Forced draft fan*	Power failure	Oil fuel burners to be shut off automatically, *see* Note 5
Air register and dampers (including those in the uptake)*	Not fully open	Purge sequences to be inhibited, *see* Pt 7, Ch 3,3.1.7
Control system*	Power failure	Oil fuel to burners to be shut-off automatically. Control using alternative arrangements is to remain available, *see* Pt 9, Ch 1,2.5.7.
Uptake temperature	High	Where economiser and/or gas air heaters are integral with the boiler and also for independent extended surface exhaust gas boilers/economisers, to monitor for soot fires.

Table 1.18.1 Boilers: Alarms and safeguards (conclusion)

NOTES
1. For dual evaporation boilers the primary circuit is to be fitted with two independent low water level detectors which will operate alarms and shut off the oil fuel to the burners automatically. The secondary circuit is to be fitted with one low water level detector which will operate alarms and shut off the oil fuel to the burners automatically. Additionally one high water level alarm is to be fitted on the secondary circuit which may be operated by the same detector as that provided for low water level detection.
2. Only one independent system of low water level detection, alarm and automatic oil fuel shut off need be fitted in the case of small forced circulation or re-circulation coiled water tube ‘package’ type boilers when evaporation is less than 2900 kg/hr or the heating surface is less than 100 m^2.
3. Where two level sensors are provided these may be used for other functions, e.g. high level alarm, level control, trip systems. etc.

~~4. Combustion spaces are to be purged automatically before re-ignition takes place in the event of a flame out on all burners~~.

~~5~~ 4. For boilers not supplying steam for propulsion or for services essential for the safety or the operation of the ship at sea, only the items marked* are required.

5. These safeguards are to remain operative during automatic, manual and emergency operation.

Volume 2, Part 9, Chapter 1

Control Engineering Systems

Effective date 1 January 2008

■ *Section 1*
General engineering systems

1.1 General requirements

1.1.8 LR will be prepared to give consideration to special cases or to arrangements which are equivalent to the Rules.

■ *Section 2*
Essential features for control, alarm and safety systems

2.4 Safety systems, general requirements

2.4.8 Where arrangements are provided for overriding a safety system, they are to be such that inadvertent operation is prevented. Visual indication is to be given at the relevant control station(s) when a safety override is operated. The consequences of overriding a safety system are to be established and documented.

2.5 Control systems, general requirements

2.5.5 Remote or automatic controls are to be provided with sufficient instrumentation (e.g. alarms and indications) at the relevant control stations to ensure effective control and indicate that the system is functioning correctly.

2.5.7 ~~Arrangements are to be such that machinery may be operated with the system of remote or automatic controls out of action.~~ Failure of a control system is not to result in the loss of ability to provide essential services by alternative means. This may be achieved by manual control or redundancy ~~arrangements~~ within the control system or redundancy in machinery and equipment, *see also* 2.12.2. Instrumentation is to be provided at local manual control stations to ensure effective operation of the machinery.

2.9 Programmable electronic systems - General requirements

2.9.7 Programmable electronic equipment is to be provided with self-monitoring capabilities such that hardware and functional failures will initiate an audible and visual alarm in accordance with the requirements of 2.3 and, where applicable, 4.2. Hardware failure indications are to enable faults to be ~~isolated~~ identifiable at least down to the level of the lowest replaceable unit and the self-monitoring capabilities are to ensure that diagnostic information is readily available.

2.9.18 ~~Where data to be displayed on mimic diagrams is known to be unreliable, the mimic diagrams are to clearly identify the unreliable data~~ Where systems detect fault conditions, any affected mimic diagrams are to ensure that the status of unreliable and incorrect data is clearly identified.

2.9.19 Multi-function displays and controls are to be duplicated and interchangeable where used for the control or monitoring of more than one system, machinery item or item of equipment. At least one unit at the main control station is to be supplied from an independent uninterruptible power ~~supply~~ system (UPS).

Volume 2, Part 10, Chapter 1

Electrical Engineering

Effective date 1 January 2008

■ *Section 1*
General requirements

1.2 Plans

1.2.18 A Failure Mode and Effects Analysis (FMEA) ~~as required by Pt 1, Ch 2~~ is ~~required~~ to be submitted. The FMEA is to ~~address~~ verify the availability of electrical power to essential services in the event of a ~~single~~ failure of a system or item of equipment ~~providing electrical power to those services listed in 1.5.1. It is not necessary to carry out the FMEA to component level, i.e. relays, printed circuit boards, etc., see Pt 1, Ch 2,17.1.5~~, *see* 5.2.4.

1.3 Surveys

1.3.2 The following equipment, where intended for use for essential and emergency services, is to be surveyed by the Surveyors during manufacture and testing:

- Converting equipment of 100 kW and over;
- Rotating machines of 100 kW and over;
- Switchboards and section boards; and
- UPS units of 50 kVA and over.

1.5 Definitions

1.5.11 'Dead ship condition' means that the entire machinery installation, including the power supply, is out of operation and that the auxiliary services for bringing the main propulsion systems into operation (e.g. compressed air, starting current from batteries, etc.) and for the restoration of the main power supply are not available. Means are to be made available to start the emergency generator at all times, *see* Pt 2, Ch 1,7.6.

1.7 Quality of power supplies

1.7.4 Unless specified otherwise, d.c. electrical equipment is to operate satisfactorily with the following simultaneous variations, from their nominal value, when measured at the consumer input terminals:

(a) When supplied by d.c. generator(s) or a rectified a.c. supply:
 Voltage tolerance (continuous) ±10%
 Voltage cyclic variation deviation 5%
 Voltage ripple 10%
 (a.c. rms over steady state d.c. voltage);
(b) When supplied by batteries:
(i) Equipment connected to the batteries during charging:
 Voltage tolerance +30%, -25%;
(ii) Equipment not connected to batteries during charging:
 Voltage tolerance +20%, -25%.

Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered. When battery chargers/battery combinations are used as d.c. power supply systems, adequate measures are to be taken to keep the voltage within the specified limits during charging, boost charging and discharging of the battery.

1.9 Ambient reference and operating conditions

1.9.3 Main and essential auxiliary machinery and equipment is to operate satisfactorily under the conditions shown in Pt 1, Ch 2,4.5. Electrical equipment satisfying alternative ambient operating condition requirements for installation on ships contained in an acceptable and relevant National, International or Naval Standard may be considered to satisfy this requirement.
~~NOTE~~
Details of local environmental conditions are stated in Annex B of IEC 60092: *Electrical installations in ships - Part 101: Definitions and general requirements*.

CORRIGENDA

1.13 Bonding for the control of static electricity

(*Part only shown*)
1.13.2 Where bonding straps are required for the control of static electricity, they are to be robust, that is, having a cross-sectional area of about 10 mm^2, and are to comply with ~~1.11.6~~ 1.12.5 and ~~1.11.8~~ 1.12.9.

Effective date 1 January 2008

1.15 Operation under fire conditions

(*Part only shown*)
1.15.1 As a minimum, the following emergency services and their emergency power supplies are required to be capable of being operated under fire conditions:

- Emergency fire pump.

(*Part only shown*)
1.15.2 Where cables for the emergency services listed in 1.15.1 pass through high fire risk areas, main vertical or horizontal fire zones other than those which they serve, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the emergency service in any other area or zone. This may be achieved either by:
Areas of high fire risk include:
(c) ~~T~~ Compartments with tanks containing flammable liquids with a flash point lower than 60°C or with a temperature above 32°C.

1.16 Protection of electrical equipment against the effects of lightning strikes

1.16.1 ~~In addition to the primary protection requirements in Section 19, p~~ Precautions are to be taken to protect essential electronic equipment that may be susceptible to damage from voltage pulses attributable to the secondary effects of lightning. This may be achieved by suitable design and/or the use of additional protective devices, such as surge arrestors. Resultant induced voltages may be further reduced by the use of earthed metallic screened cables. *See also* Section 19.

■ *Section 2*
Main source of electrical power

2.3 Starting arrangements

2.3.2 When the emergency source of electrical power is required to be used to restore propulsion from a dead ship condition, the emergency generator is to be capable of providing initial starting energy for the propulsion machinery within 30 minutes of the dead ship condition. The emergency generator capacity is to be sufficient for restoring propulsion in addition to supplying those services in Section 3. See Pt 2, Ch 1,7 for ~~initial~~ dead ship condition starting arrangements.

■ *Section 3*
Emergency and alternative sources of electrical power

3.2 Emergency source of electrical power

3.2.12 In order to ensure ready availability of the emergency source of electrical power~~, and to ensure its continued safe operation, arrangements are to be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that electrical power will be available automatically to the emergency circuits~~ to supply circuits required to provide emergency services, arrangements are to be made, where necessary, to automatically disconnect non-emergency circuits from the emergency switchboard in the event of overloading to ensure that electrical power is available to the emergency circuits.

■ *Section 5*
Supply and distribution

5.2 Essential services

5.2.4. A Failure Mode and Effects Analysis (FMEA) is to be carried out in accordance with the requirements of Pt 1, Ch 2,17. The FMEA is to verify the availability of electrical power to essential services (*see* 1.5.1) in the event of a failure in the power supply and distribution system. The FMEA is to address the different system operating modes and configurations. The FMEA should include relevant mechanical failures which may have significant effects on the electrical power and distribution system, i.e. prime mover failures causing loss of electrical power supplies used to provide essential services. An analysis carried out by applying the relevant generic failure modes listed in IEC 60812:1985, *Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)*, to the system and equipment identified in the single line diagram of the electrical system (*see* 1.2.2) would generally be acceptable.

■ *Section 6*
System design - Protection

6.1 General

6.1.6 Protection for battery circuits is to be provided at a position external and adjacent to the battery compartments. Where arrangements comply with 11.3.5, the protection may be installed at a suitable location in the battery compartment.

■ *Section 7*
Switchgear and control gear assemblies

7.11 Instruments for alternating current generators

7.11.4 Where the indications of voltage, frequency, current and power are displayed digitally, ~~in order to facilitate manual synchronising,~~ the indications ~~required by 7.11.3~~ are to be separately displayed.

7.12 Instrument scales

7.12.4 Where the indications provided by the instrumentation required by 7.11 are displayed digitally, nominal voltage, over voltage, over current and reverse power indications are to be indicated by an appropriate means. The information provided is to be clearly visible and immediately available.

■ *Section 9*
Converter equipment

9.2 Semiconductor equipment

9.2.18 Tests at the manufacturer's works of converter equipment and any associated reactors or filters are to include the high voltage test of 20.1, a temperature rise test~~, where practical,~~ on one of each size and type of converter equipment, and such other tests as may be necessary to demonstrate the suitability of the equipment for its intended duty. ~~Where a temperature rise test cannot be carried out at the manufacturer's works, it is to form part of the sea trials programme.~~ Details of tests are to be submitted for consideration when required, *see also* 1.3.2.

9.3 Uninterruptible power systems

9.3.1 Where uninterruptible power systems (UPS) are required to maintain essential services or provide emergency services, the requirements of this sub-Section apply. This sub-Section is in addition to the requirements of 9.1, 9.2 and Section 11, as applicable.

9.3.2 UPS units are to be constructed in accordance with IEC 62040: *Uninterruptible power systems (UPS)*, or an acceptable and relevant National or International Standard.

9.3.3 The operation of a UPS is not to depend upon external services.

9.3.4 The type of UPS unit employed, whether off-line, line-interactive or on-line, is to be appropriate to the power supply requirements of the connected load equipment.

9.3.5 An external bypass, that is hardwired and manually operated, is to be provided for UPS to allow isolation of UPS for safety during maintenance and maintain continuity of load power.

9.3.6 UPS units are to be monitored and an audible and visual alarm is to be initiated in the navigating bridge or the engine control room, or an equivalent attended location for:

- power supply failure (voltage and frequency) to the connected load;
- earth fault;
- operation of battery protective device;
- battery discharge; and
- bypass in operation for on-line UPS units.

9.3.7 UPS units required to provide emergency services are to be suitably located for use in an emergency.

9.3.8 UPS units utilising valve-regulated sealed batteries may be located in compartments with standard marine or industrial electrical equipment provided that the arrangements comply with 11.3.5. Ventilation arrangements in accordance with IEC 62040: *Uninterruptible power systems (UPS)*, or an acceptable and relevant National or International Standard, may be considered to satisfy the requirements of 11.5.10.

9.3.9 Output power is to be maintained for the duration required for the connected equipment.

9.3.10 The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified. Where it is proposed that additional circuits are connected to the UPS unit, details verifying that the UPS unit has adequate capacity are to be submitted for consideration, *see* 1.4.

9.3.11 On restoration of the input power, the rating of the charge unit is to be sufficient to recharge the batteries in a reasonable time while maintaining the output supply to the load equipment.

9.3.12 Tests at the manufacturer's works are to include such tests necessary to demonstrate the suitability of a UPS unit for its intended duty and location. This is expected to include as a minimum the following tests:

- a temperature rise test and battery capacity test on one of each size and type of UPS;
- the high voltage test of 20.1;
- a ventilation rate test; and
- functional testing, including operation of alarms.

Details of tests are to be submitted for consideration when required, *see also* 1.3.2.

9.3.13 Where the supply is to be maintained without a break following a power input failure, this is to be verified after installation by practical testing.

■ *Section 10*
Electric cables and busbar trunking systems (busways)

10.5 Construction

10.5.1 Electric cables are to be at least of a flame-retardant, low smoke, halogen free type. Compliance with ~~IEC 60332-1: *Tests on a single vertical insulated wire or cable*~~ IEC 60332-1-2: *Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1kW pre-mixed flame*, IEC 61034: *Measurements of smoke density of electric cables burning under defined conditions*, IEC 60754: *Tests on gases evolved during combustion of materials* from cables will be acceptable. Where cables are installed in bunches, the requirements of 10.8.8 are to be satisfied.

10.5.3 Where electric cables are required to be of a 'fire resistant type', they are in addition to be easily distinguishable and comply with the performance requirements of the appropriate part of IEC 60331: ~~Fire characteristics of electric cables~~ *Tests for electric cables under fire conditions - Circuit integrity*, when tested with a minimum flame application time of 90 minutes, as follows:
IEC 60331-21: *Procedures and requirements - Cables of rated voltage up to and including 0.6/1.0kV*;
IEC 60331-23: *Procedures and requirements - Electric data cables*;
IEC 60331-25: *Procedures and requirements - Optical fibre cables*; or
IEC 60331-31: *Procedures and requirements - Cables of rated voltage up to and including 0.6/1.0kV*, where the overall diameter of the cable exceeds 20 mm.

10.8 Installation of electric cables

10.8.8 Where electric cables are installed in bunches, provision is to be made to limit the propagation of fire. This requirement is considered satisfied when cables of the bunch have been tested in accordance with the requirements of ~~IEC 60332-3, Category A/F~~ IEC 60332:*Tests on electric cables under fire conditions, Part 3-22, Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A*, provided that, in addition, there is no shedding of flaming droplets of sheath or insulation material and that they are installed to the same configuration(s) as used in the test(s). If the cables are not so installed, information is to be submitted to satisfactorily demonstrate that suitable measures are taken to ensure that an equivalent limit of fire propagation will be achieved for the configuration(s) used. Particular attention is to be given to cables in vertical runs in trunks and other restricted spaces. In addition, cables which comply with the requirements of ~~IEC 60332-3~~ IEC 60332-3-22 are also required to meet the requirements of ~~IEC 60332-1~~ IEC 60332-1-2.

■ *Section 11*

Batteries

11.3 Location

11.3.9 Only electrical equipment necessary for operational reasons and for the provision of lighting is to be installed in compartments provided in compliance with 11.3.1. Such electrical equipment is to be certified for group IIC gases and temperature Class T1 in accordance with IEC 60079: *Electrical apparatus for explosive gas atmospheres*, or an acceptable and relevant National Standard.

~~11.7 Electrical equipment~~

~~*11.7.1* Only electrical equipment necessary for operational reasons and for the provision of lighting is to be installed in compartments provided in compliance with 11.3.1. Such electrical equipment is to be certified for group IIC gases and temperature Class T1 in accordance with IEC 60079: *Electrical apparatus for explosive gas atmospheres*, or an acceptable and relevant National Standard.~~

Existing sub-Section 11.8 is to be renumbered 11.7

■ *Section 13*

Electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts

13.1 General

13.1.1 The installation of electrical equipment in spaces and locations in which flammable mixtures are liable to collect, e.g. areas containing flammable gas or vapour and/or combustible dust, is to be minimised as far as is consistent with operational necessity and the provision of lighting, monitoring, alarm or control facilities enhancing the overall safety of the ship.

13.1.2 In order to eliminate potential sources of ignition from spaces and locations in which flammable mixtures are liable to collect, such dangerous or hazardous areas are to be identified and electrical equipment within these areas is to be selected and installed in accordance with the requirements of this Section.

Existing paragraph 13.1.2 is to be re-numbered 13.1.3.

■ *Section 17*

Crew and embarked personnel emergency safety systems

17.4 Escape route or low location lighting (LLL)

17.4.2 The LLL system is to be provided with an emergency source of electrical power as required by 3.2 and also be connected to the main source of electrical power, with automatic changeover facilities located adjacent to the control panel, *see also* 1.14.

Volume 3, Part 1, Chapter 3

Dynamic Positioning Systems

Effective date 1 January 2008

■ *Section 2*

Class notation DP(CM)

2.3 Electrical systems

2.3.10 Any loads that require an uninterrupted electrical power supply are to be provided with uninterruptible power systems (UPS) ~~systems~~ having a capacity for a minimum of 30 minutes' operation following loss of the main supply.

Volume 3, Part 1, Chapter 4

Bridge Navigational Arrangements

Effective date 1 January 2008

■ *Section 1*

General requirements

1.2 Information and plans required to be submitted

(*Part only shown*)
1.2.1 The following information and plans are to be submitted in triplicate:

- A schedule of the electrical and electronic equipment referred to in 2.2.10 giving details of:
  - equipment description;
  - manufacturer;
  - type and/or model; and
  - evidence of electromagnetic compatibility.

1.3 Definitions

(*Part only shown*)
1.3.1 The following definitions are applicable to these Rules:

On the bridge or in the vicinity of the bridge:
Refers to the deck and bridge zone defined in IEC 60533: *Electrical and electronic installations in ships - Electromagnetic compatibility*, that covers:

- the wheelhouse, including bridge wings;
- control rooms, characterized by equipment for intercommunication, signal processing, radio communication and navigation, auxiliary equipment; and
- area in close proximity to receiving and/or transmitting antennas and large openings in the metallic structure (equipment beyond 5 meters need not be considered for these purposes).

■ *Section 2*

Physical conditions

2.2 Environment

2.2.9 Permanently installed electrical and electronic equipment is to be installed so that electromagnetic interference does not affect the proper function of the navigational systems and equipment. Installation of the equipment in accordance with the guidelines and recommendations included in IEC 60533: *Electrical and electronic installations in ships - Electromagnetic compatibility*, or an acceptable equivalent standard, would generally be considered to meet the requirement.

2.2.10 Permanently installed electrical and electronic equipment on the bridge or in the vicinity of the bridge that is not subject to the approval required by 3.1.13, is to have undergone electromagnetic compatibility testing that demonstrates the equipment satisfies the conducted and radiated emission requirements of:

- IEC 60533: *Electrical and electronic installations in ships - Electromagnetic compatibility*; or
- IEC 60945: *Maritime navigation and radio communication equipment and systems - General requirements - Methods of testing and required test results*.

Testing in accordance with other appropriate standards is subject to consideration and details are to be submitted.

2.2.11 To demonstrate compliance with 2.2.10, a schedule of applicable equipment is to be compiled, *see* 1.2.1. Where it is proposed to add to or modify the equipment referred to in 2.2.10, the schedule is to be maintained accordingly, *see also* 6.1.1. A copy of the schedule documentation is to be placed on board the vessel and a copy is to be made available to the LR Surveyor on request.

2.2.12 Passive electromagnetic equipment, considered not liable to cause or be susceptible to electromagnetic disturbances, may be provided with an exemption statement in place of evidence of electromagnetic compatibility for the purposes of 2.2.11. Examples of passive electromagnetic equipment include cables, purely resistive loads and batteries.

■ *Section 3*
Workstations

3.1 Navigation workstation

(*Part only shown*)
3.1.4 The following facilities are to be provided at the navigation workstation:

- Speed and distance indications, see ~~3.1.10~~ 3.1.11 and ~~3.1.11~~ 3.1.12.
- Course/track controls and indications, *see* 3.1.8 ~~and 3.1.9~~ to 3.1.10.

3.1.7 A gyrocompass or alternative means for determining by shipborne, non-magnetic means, displaying and transmitting the ship's heading is to be provided and is to be clearly readable by the helmsman at the main steering position. The heading information is to be used directly by the radars, radar plotting aids and automatic identification system, *see* 3.1.5 and ~~3.1.12~~ 3.1.13. The gyrocompass is to be provided with a gyrocompass heading repeater located at the emergency steering position in the steering gear compartment and a gyrocompass bearing repeater allowing bearings to be taken over 360°.

3.1.9 Heading monitoring is to be provided to monitor the actual heading information by independent heading sources. An off-course warning is to be given if the actual heading of the ship deviates from the set track course beyond a pre-set value. The pre-set off-course warning limit is to be large enough to prevent unnecessary alarms.

Existing paragraphs 3.1.9 to 3.1.13 are to be re-numbered 3.1.10 to 3.1.14.

~~*3.1.14* Electrical and electronic equipment shall be installed so that electromagnetic interference does not affect the proper function of the navigational systems and equipment. Installation of the equipment in accordance with the guidelines and recommendations included in *IEC 60533 Electrical and electronic installations in ships – Electromagnetic compatibility* or an acceptable equivalent standard would generally be considered to meet the requirement.~~

■ *Section 5*
Integrated Bridge Navigation System - IBS notation

5.3 Equipment

5.3.2 Only one gyrocompass is to be used by the integrated bridge system at any time for main display and control purposes. The navigating officer is to be able to switch between compasses at any time. ~~and t~~ The non-selected compass is to be used automatically as the independent heading source for the off-course warning required by ~~3.1.8~~ 3.1.9.

(*Part only shown*)
5.3.13 The following alarms are to be provided and included in the centralized alarm system specified by 4.1.1:

- off-track ~~(see 3.1.8)~~;
- waypoint approaching (see ~~3.1.9~~ 3.1.10);

Volume 3, Part 2, Chapter 3
Provision Refrigeration

Effective date 1 January 2008

■ *Section 1*
General requirements

1.1 General

1.1.1 This Chapter states the requirements for ships having centralised refrigeration systems, designed to reject heat from provision refrigerated stores and are in addition to the relevant requirements of the *Rules and Regulations for the Classification of Naval Ships* (hereinafter referred to as the Rules for Naval Ships) contained in Volumes 1 and 2.

1.1.2 The requirements, which are optional, cover arrangements, equipment, and systems necessary for effective provision refrigerated stores arrangements on board a naval ship.

1.1.3 The Naval Authority may impose requirements additional to those in this Chapter.

1.1.4 Ships complying with the applicable requirements of this Chapter will be eligible for the optional machinery class notation **PRM** (Provision Refrigeration Machinery).

1.2 Plans and information

1.2.1 Three copies of the plans and information stated in 1.2.2 to 1.2.6 are to be submitted to Lloyd's Register (hereinafter referred to as 'LR') as applicable.

1.2.2 **Design statement**.A design statement of the refrigeration system(s) that details system capability and functionality under defined operating and emergency conditions within the normal concept of operation role of the ship. The arrangements for refrigerated stores for the ship are to be agreed between the Designer and the Owner/Operator and are to be included in the design statement.

1.2.3 **Systems**.Plans in diagrammatic form showing refrigerant and cooling systems, control systems and safeguards and electrical systems covered by this Chapter. Plans are to show pipe sizes, flows and terminal locations. The capacities of fans and pumps are to be included. Capacity tables for different operating conditions for the refrigeration compressors are also to be included.

1.2.4 **Compartments**.Plans showing the general arrangement of refrigeration plant compartments, together with a description of the equipment and arrangements installed for isolation and distribution of ventilation air and the electrical power supply systems. The plans are to indicate segregation and access arrangements for compartments and associated control rooms/stations.

1.2.5 **Testing and trials procedures**.A schedule of testing and trials to demonstrate that systems are capable of operating as described in Section 3 and as required by Section 7.

1.2.6 **Operating manuals**.Operating manuals are to be submitted for information and provided on board. The manuals are to include the following information:

(a) Particulars and a description of the systems.
(b) Operating instructions for the equipment and systems (including fire isolation aspects).
(c) Maintenance instructions for the installed arrangements.

■ *Section 2*
Construction and installation

2.1 Materials

2.1.1 The selection of materials in piping systems for provision refrigeration systems is to recognise the following details:

(a) Fluids, pressures and temperatures.
(b) Location.
(c) Compatibility of materials.
(d) Fluid flow rates and static conditions.
(e) Minimising corrosion and erosion through life of system.
(f) Flammability and toxicity.

2.1.2 Pipes, valves and fittings are in general to be made of steel, ductile cast iron, copper, copper alloy, or other approved ductile material suitable for the intended purpose. The use of plastics materials is also acceptable subject to the restrictions in Vol 2, Pt 7, Ch 1.

2.1.3 Where applicable, the materials are to comply with the requirements of Vol 2, Pt 7, Ch 1.

2.2 Equipment - Selection and installation

2.2.1 Pressure vessels in provision refrigeration systems are to be in accordance with Vol 2, Pt 8, Ch 2 or an alternate recognised code and satisfy the Naval Authority's revalidation system for such items where applicable.

2.2.2 Valves, flexible hose lengths, expansion pieces and pumps are to comply with the relevant requirements of Vol 2, Pt 7, Ch 1,12 to 15.

2.2.3 Pipes in piping systems are to be permanent pipes made with approved pipe connections to enable ready removal of valves, pumps, fittings and equipment. The pipes are to be efficiently secured in position to prevent chafing or lateral movement.

2.2.4 Suitable means for expansion is to be made, where necessary, in each range of pipes.

2.2.5 Suitable protection is to be provided for all pipes and equipment situated where they are liable to mechanical damage.

2.2.6 All moving parts are to be provided with guards to minimise danger to personnel.

2.2.7 Low temperature pipes in refrigeration systems are to be provided with suitable insulation.

2.3 Valves and relief devices

2.3.1 Valves are to be fitted in places where they are at all times readily accessible.

2.3.2 Relief valves are to be adjusted and bursting discs so selected that they relieve at a pressure not greater than the design pressure of the system. When satisfactorily adjusted, relief valves are to be protected against tampering or interference by wire with a lead seal or similar arrangement.

2.4 Refrigerant systems

2.4.1 Refrigeration plants are to be provided and designed to be capable of extracting the defined heat load duty when operating in accordance with the conditions stated in the design statement required by 1.2.2.

2.4.2 The compartments containing the refrigeration plants are to be provided with refrigerant gas detectors with an alarm.

2.4.3 The design of refrigeration systems is to be such that it permits maintenance and repair without unavoidable loss of refrigerant to the atmosphere. To minimise refrigerant release to the atmosphere, refrigerant recovery units are to be provided for evacuation of a system prior to maintenance.

2.4.4 Refrigeration systems are to be provided with relief devices, but it is important to avoid circumstances that would bring about an inadvertent discharge of refrigerant to the atmosphere. The system is to be so designed that pressure due to fire conditions will be safely relieved.

2.4.5 A pressure relief valve and/or bursting disc is to be fitted between each positive displacement compressor and its gas delivery stop valve, the discharge being led to the suction side of the compressor. The flow capacity of the valve or disc is to exceed the full load compressor capacity on the particular refrigerant at the maximum potential suction pressure. For these internal relief valves, servo-operated valves will be accepted. Where the motive power for the compressor does not exceed 10 kW, the pressure relief valve and/or bursting disc may be omitted.

2.4.6 Each pressure vessel which may contain liquid refrigerant and which is capable of being isolated by means of a stop or automatic control or check valves is to be protected by two pressure relief valves or two bursting discs, or one of each, controlled by a changeover device. Pressure vessels that are connected by pipework without valves, so that they cannot be isolated from each other, may be regarded as a single pressure vessel for this purpose, provided that the interconnecting pipework does not prevent effective venting of any pressure vessel.

2.4.7 Omission of one of the specified relief devices and changeover device, as required by 2.4.6, will be accepted where:

(a) Vessels are of less than 300 litres internal gross volume; or
(b) Vessels discharge into the low pressure side by means of a relief valve.

2.4.8 Sections of systems and components that could become full of liquid between closed valves are to be provided with pressure relief devices relieving to a suitable point in the refrigerant circuit.

2.4.9 Where hermetically sealed compressor units or semi-hermetic compressors with the electric motor cooled by the circulating refrigerant are installed, the following arrangements are to be made:

(a) Each refrigeration system containing hermetically sealed compressor units or semi-hermetic compressors is to be independent of other refrigeration systems.
(b) All hermetic motor-compressors are to be fitted with a thermal cut-out device that protects the motor against overheating.
(c) Each refrigerant circuit is to be designed such that debris or contaminants from a motor failure, typically burn out of insulation, is contained and not distributed around the system.
(d) The pressure envelope of any hermetic or semi-hermetic compressor exposed to the refrigerant pressure is to be designed and constructed in accordance with the requirements of Vol 2, Pt 8, Ch 2 and Pt 1, Ch 3 as applicable. Plans are to be submitted for consideration as required by Vol 2, Pt 6, Ch 2,1.6.

2.4.10 Seawater systems for refrigeration condensers are to be capable of being supplied from not less than two independent sources. If required by the Naval Authority, these sources are to be located in separate compartments and zones such that the loss of one zone or compartment will not result in the loss of all seawater supply sources.

2.4.11 The capacity of each source of seawater required by 2.4.10 is to be sufficient for the conditions stated in the design statement with any one source out of action.

2.5 Air coolers and cooling grids

2.5.1 Refrigerated spaces may be cooled by air coolers or cooling grids on the deckhead, bulkheads, and sides. In order to minimize the dehydration of the stores and the frosting of the air coolers or cooling grids, the installation is to be designed to maintain the required temperatures as defined in the design statement with a minimum of difference between the refrigerant and space temperatures.

2.5.2 The refrigeration capacity of the air cooler arrangement is to be such that the provisions room temperature conditions defined in the design statement can be maintained under normal operating conditions. The capacities of the fans are also to be such that they can maintain the required air flow rates and uniform air temperature throughout the refrigerated spaces, when part or fully loaded with stores.

2.5.3 Air cooler fan motors are to be suitably enclosed to withstand the effects of moisture.

2.5.4 Means are to be provided for effectively defrosting air coolers. Air coolers are to be provided with trays of suitable depth arranged to collect all condensate. The trays are to be provided with drains at their lowest points to enable the condensate to be drained away when the refrigerated spaces are in service. Provision is to be made for the prevention of freezing of the condensate.

2.5.5 Air coolers are to be located such that when the refrigerated spaces are loaded with stores, adequate space is provided for the inspection, servicing and renewal of controls, valves, fans and fan motors.

2.5.6 Steel air cooler circuits and cooling grids are to be suitably protected against external corrosion.

2.6 Refrigeration units

2.6.1 A refrigerating unit is considered to comprise a compressor, its driving motor and one condenser. Where a secondary refrigerant, such as brine, is employed, the unit is also to include an evaporator (secondary refrigerant cooler) and a secondary refrigerant pump.

2.6.2 Two or more compressors driven by a single motor, or having only one condenser or evaporator/secondary refrigerant cooler are to be regarded as one unit.

2.6.3 The refrigerating units of a classed provision stores installation are to be completely independent of any refrigerating machinery associated with air conditioning plant, unless full details of any proposal have been submitted and approved.

2.7 Design pressures

2.7.1 The design pressure of the system will be regarded as equal to its maximum working pressure.

2.7.2 The maximum working pressure is the maximum permissible pressure within the system (or part system) in operation or at rest. No relief valve is to be set to a pressure higher than the maximum working pressure.

2.7.3 The design pressure of the low pressure side of the system is to be the saturated vapour pressure of the refrigerant at plus 46°C. Due regard is to be taken of defrosting arrangements which may cause a higher pressure to be imposed on the low pressure system.

2.7.4 The minimum design pressure of the high pressure side of the system (P_{dh}), is to be 1,11 × P_b, where P_b is an allowance for the compressor high pressure cut-out. P_b is to be at least equal to 1,11 × P_a, where P_a is the condenser working pressure, when operating in tropical zones and equates to the saturation pressure at 46°C.

2.7.5 Design pressures (bar g) applicable to refrigerants are to be not less than the values given in Table 3.2.1 when condensers are sea-water cooled. The design pressure for other refrigerants is to be agreed with LR.

Table 3.2.1 Pressure limits

Refrigerant	Pressure (bar g)	
	High	Low
R-22	20,6	16,7
R-290	18,1	14,7
R-600a	6,4	5,2
R-134a	13,4	10,9
R-407C	23,5	19,0
R-410A	34,5	28,0
R-507A	25,3	20,5
R-404A	24,8	20,1

NOTE
In view of increasing world-wide restrictive legislation and phasing out of the refrigerant R-22, it is recommended that this refrigerant should not be used in any new installation.

2.8 Room insulation

2.8.1 Where applicable, having regard to their location and environmental conditions, insulation materials are to be:

- suitably resistant to fire;
- suitably resistant to the spreading of flame;
- adequately protected against penetration of water vapour; and
- adequately protected against mechanical damage.

2.8.2 The potential for smoke generation and its toxicity is to be in accordance with SOLAS Chapter 2, Part B, Regulation 6.

2.8.3 Where the *in situ* foam type of insulation is proposed, full details of the process are to be submitted for approval.

■ *Section 3*
Refrigerating machinery and refrigerant storage compartment arrangements

3.1 General

3.1.1 Refrigerating machinery is to be located in a well ventilated compartment. In general, the arrangements are to be such that all components of the refrigerating machinery can be readily opened up for inspection or replacement. Space is to be provided for the withdrawal and renewal of the tubes in `shell-and-tube' type evaporators (secondary refrigerant coolers) and condensers. Proposals for alternative arrangements are to be submitted to LR for consideration.

3.1.2 Refrigerating machinery using toxic and/or flammable refrigerants is to be located outside the main machinery space in a separate gastight compartment.

3.1.3 Where the refrigerating machinery is located in a separate gastight compartment, outside the main machinery space, this compartment is to be equipped with effective mechanical ventilation to provide 30 air changes per hour based upon the total volume of the space. The mechanical ventilation is to have two main controls, one of which is to be operable from a place outside the compartment.

3.1.4 Openings for pipes, electrical cables and other fittings in the bulkheads and deck are to be fitted with gastight seals.

3.2 Gas storage compartments

3.2.1 Portable steel cylinders containing reserve supplies of refrigerant are to be stored in the refrigerating machinery space or a well ventilated compartment reserved solely for this purpose.

3.2.2 The storage compartment is to be provided with a mechanical ventilation system providing 10 air changes per hour.

3.2.3 The storage compartment is to be provided with a suitable vapour detection system.

3.2.4 The storage compartment is to be provided with suitable water drainage arrangements not connected with the main machinery spaces.

3.2.5 Steel storage cylinders are to be of an approved type and are to be filled to a level suitable for an ambient temperature of plus 46°C.

3.2.6 The storage compartment is to be provided with racks to facilitate secure stowage of the cylinders.

3.3 Pressure testing at manufacturers' works

3.3.1 Components intended for use with a primary refrigerant are to be subject to strength and leak pressure tests as detailed in Table 3.3.1.

3.3.2 Component strength pressure tests are to be hydraulic or where suitable safety measures are taken, may be pneumatic. The latter is to be carried out with a suitable dry inert gas.

3.3.3 Component leakage pressure tests are to be carried out only after completion of satisfactory strength pressure tests. Pneumatic pressure is to be applied using a suitable dry inert gas.

3.3.4 Components for use with a secondary refrigerant or cooling water are to be hydraulically tested to 1,5 times the design pressure, which in no case is to be less than 3,5 bar g.

3.4 Pressure test after installation on board ship

3.4.1 For primary refrigerant piping welded in place, strength pressure tests of the welds are to be carried out at a test pressure of 1,5p. This will normally take the form of a pneumatic test since hydraulic testing media such as water are not acceptable due to their incompatibility with the primary refrigerants and the difficulty of removing all traces from a completed system.

3.4.2 Pneumatic pressure tests are to be carried out using a suitable inert gas. All pneumatic tests are potentially dangerous and due precautions are to be observed.

3.4.3 Where pneumatic tests are prohibited by relevant authorities, the tests required by 3.3.1 and 3.3.2 may be omitted provided non-destructive examination has been carried out by an approved operator to the satisfaction of LR and in accordance with the requirements of Pt 1, Ch 3,7.

3.4.4 After completion of the test required by 3.3.1, 3.3.2 or 3.3.3, a leak pressure test is to be carried out using a suitable inert gas at a pressure equal to the design pressure, in the presence of the Surveyor.

3.4.5 Secondary refrigerant piping welded in place is to be hydraulically tested to 1,5 times the design pressure, which in no case is to be less than 3,5 bar g.

Table 3.3.1 Test pressure

Component	Test pressure, (bar g)	
	Strength test	Leakage test
1.Pressure vessels	*See* Vol 2, Pt 8, Ch 2	1,0p
2.Compressor cylinders/ crankcase/casing	1,5p	1,0p
3.Valves & fittings	2,0p	1,0p
4.Pressure piping, fabricated headers, air coolers, etc.	1,5p	1,0p

NOTE
p is the design pressure as defined in 2.7.

■ *Section 4*
Refrigerant detection systems

4.1 General

4.1.1 A fixed refrigerant detection system is to be provided in the refrigerating machinery compartment or space and ventilation outlet ducts when the ventilation system is shared with other compartments.

4.1.2 The alarm system is to comply with the requirements of Vol 2, Pt 9, Ch 1 and, as a minimum requirement, the system is to activate at a low-level concentration to give warning of refrigerant leaks, and a high-level concentration corresponding to the refrigerant's safe occupational level.

4.1.3 Detection equipment is to be so designed that it may be readily tested and calibrated, and failure of the equipment is to initiate an alarm.

4.1.4 The location of the detectors is to be determined relative to the layouts of the individual compartments and machinery spaces and are to be indicated on the plan submission.

4.1.5 Audible and visual alarms are to be activated, located both inside and outside the affected space. The alarms are to be readily identifiable and be visible and audible in all locations within the space housing the refrigeration equipment.

■ *Section 5*

Control and monitoring and electrical power arrangements

5.1 General

5.1.1 The control engineering arrangements are to comply with Vol 2, Pt 9, Ch 1 as applicable.

5.1.2 The equipment used in provision refrigeration systems is to be provided with local control and monitoring arrangements.

5.1.3 Where isolation of equipment or systems can be carried out, means of indicating the status of isolation is to be provided at positions where the equipment and system can be operated and monitored.

5.1.4 Instrumentation to indicate the operational status of running and any standby equipment is to be provided locally and at any control station.

5.1.5 All cooling and secondary refrigerant pumps are to be provided with an indication of discharge pressure and a low discharge pressure alarm at each control station.

5.1.6 The power to all independently driven ventilation fans is to be capable of being stopped from position(s) outside the fire boundary which will always be readily accessible in the event of fire occurring in any space, as well as from the local control panel.

5.1.7 Electrical engineering arrangements are to comply with Vol 2, Pt 10, Ch 1.

5.1.8 Refrigeration compressors are to be provided with the following instrumentation and automatic shutdowns:

(a) Indication of suction pressure (saturated temperature), including intermediate stage when applicable.
(b) Indication of discharge pressure (saturated temperature), including intermediate stage when applicable.
(c) Indication of lubricating oil pressure.
(d) Indication of cumulative running hours.
(e) Automatic shutdown in the event of low lubricating oil pressure.
(f) Automatic shutdown in the event of high discharge pressure which is to operate at a pressure in excess of normal operating pressure but not greater than 0,9 of the maximum working pressure.
(g) Automatic shutdown in the event of a low suction pressure.

5.1.9 For refrigeration compressors greater than 25 kW, the following instrumentation, additional to that required by 5.1.8, is to be provided:

(a) Indication of lubricating oil temperature.
(b) Indication of cooling water outlet temperature.
(c) Indication of cumulative running hours (reciprocating compressors).
(d) Indication of suction and discharge temperatures.

5.1.10 Alarms are to be initiated in the event of the following fault conditions with refrigeration compressors:

(a) High discharge pressure.
(b) Low suction pressure.
(c) Low oil pressure.
(d) High discharge temperature.
(e) High oil temperature.
(f) Motor shutdown.

5.1.11 Refrigeration plants are to be provided with the following alarms as applicable:

(a) Failure of condenser cooling water pumps.
(b) High condenser cooling water outlet temperature.
(c) Failure of air cooler fans.
(d) High and low refrigerated air delivery temperatures.
(e) High secondary refrigerant temperatures.
(f) Failure of secondary refrigerant pump.
(g) Low level in secondary refrigerant header tank.

■ *Section 6*

Personnel safety equipment and systems

6.1 Personnel safety equipment

6.1.1 Access doors to the refrigerated spaces are to open outwards and an external locking arrangement is to be provided to prevent unauthorised access.

6.1.2 Access ways to the refrigerated spaces are to be designed to facilitate escape in emergencies, and the removal of stretcher-borne personnel.

6.1.3 Access ways and refrigerated compartments are to be provided with an independent lighting system in accordance with the requirements of Vol 2, Pt 10, Ch 1,5.7.2 and 5.7.4, with the means of locking the switches in the `on' position.

6.1.4 Arrangements are to be such that means of both opening the room door(s) and sounding the alarm required by 6.2.2 from inside refrigerated spaces are provided.

6.2 Personnel warning systems

6.2.1 A system to monitor the well-being of crew members entering refrigerated spaces is to be provided.

6.2.2 The system is to be such that at a predetermined time, after initiation, the crew member(s) receives warning that the system is to alarm and must indicate their well-being by accepting the warning.

6.2.3 The system is to be designed and arranged such that only an authorized person has access for enabling and disabling it and setting the appropriate intervals, and such that it cannot be operated in an unauthorized manner.

6.2.4 It is to be possible to acknowledge the warning by means of illuminated switches situated near the access doors or hatches of each refrigerated space or chambers within the space.

6.2.5 In the event that the crew member(s) fails to respond and accept the warning within an agreed specified time, the system is to immediately initiate an alarm on the bridge and at the main control station, or subsidiary control stations as appropriate. Manual initiation of the alarm system from the refrigerated spaces is to be possible at any time.

6.2.6 The system is to comply with the relevant requirements of Vol 2, Pt 9, Ch 1.

■ *Section 7*
Testing and trials

7.1 Testing

7.1.1 The requirements of the Rules relating to testing of pressure vessels, piping and related fittings including hydraulic testing are applicable. *See* Vol 2, Pt 8, Ch 2,10 and Pt 7, Ch 1,16.

7.1.2 On completion, tanks and reservoirs for service and storage of system fluids are to be tested by a head of water equal to the maximum to which the tanks may be subjected, but not less than 2,5 m above the crown of the tank.

7.1.3 After installation on board, piping systems together with associated fittings that are under internal pressure, are to be subjected to a running test at the intended maximum working pressure.

7.1.4 Testing is to cover the following items:

(a) Verification of control, alarm, safety systems.
(b) Tests simulating failure of refrigeration equipment to verify correct functioning of alarms and systems in service.
(c) Verification of accuracy, calibration and functioning of temperature control for refrigeration systems.

7.2 Type testing

7.2.1 Evidence that the required performance of refrigeration systems, pump and fan equipment is capable of being maintained under ambient and inclination operating conditions defined in Vol 2, Pt 1, Ch 2,4.4 to 4.6 is to be provided by the manufacturer.

7.3 Trials

7.3.1 Trials are to be carried out to demonstrate that the capability of the provision refrigeration systems meets the design statement. The trials are as far as practicable to be representative of the actual conditions to be encountered in service.

Volume 3, Part 3, Chapter 4

Life-saving and Evacuation Arrangements

Effective date 1 January 2008

■ *Section 8*

Command and control

8.1 Command and control objective

(Part only shown)
8.1.2 **Command and Control Goal 1.** Every ship is to be equipped and manned so that command of all life-saving and evacuation situations can be maintained:

(a) Every ship is to be fitted with a general emergency alarm in accordance with SOLAS Chapter III, Part B, Regulation ~~6.4.4~~ 6.4.2 as applicable. The alarm is to be audible on all open decks and every compartment.

Section numbering in brackets reflects any Section renumbering necessitated by any of the Notices that update the current version of the Rules for Naval Ships.

Volume 1, Part 4, Chapter 1

6.5.1	Reference to 6.1.2 *now reads* 6.1.3.

Volume 2, Part 2, Chapter 2

5.2.1	Reference to Ch 3,3.10 *now reads* Ch 3,3.9.

Volume 2, Part 7, Chapter 3

2.10.2	Reference to 3.10.3 *now reads* 3.9.3.
3.12.1 *(3.11.1)*	Reference to sub-Section 3.11 *now reads* sub-Section 3.10
10.1.2a	Reference to 3.11.2 *now reads* 3.10.2.

Volume 2, Part 10, Chapter 1

1.2.12	Reference to sub-Section 11.8 *now reads* sub-Section 11.7.

Volume 3, Part 1, Chapter 4

5.3.11	Reference to 3.1.9 *now reads* 3.1.10.

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